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# CHANGES OF THE BLOOD IN DISEASE.

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TRANSLATED FROM THE FRENCH OF M. GIBERT,

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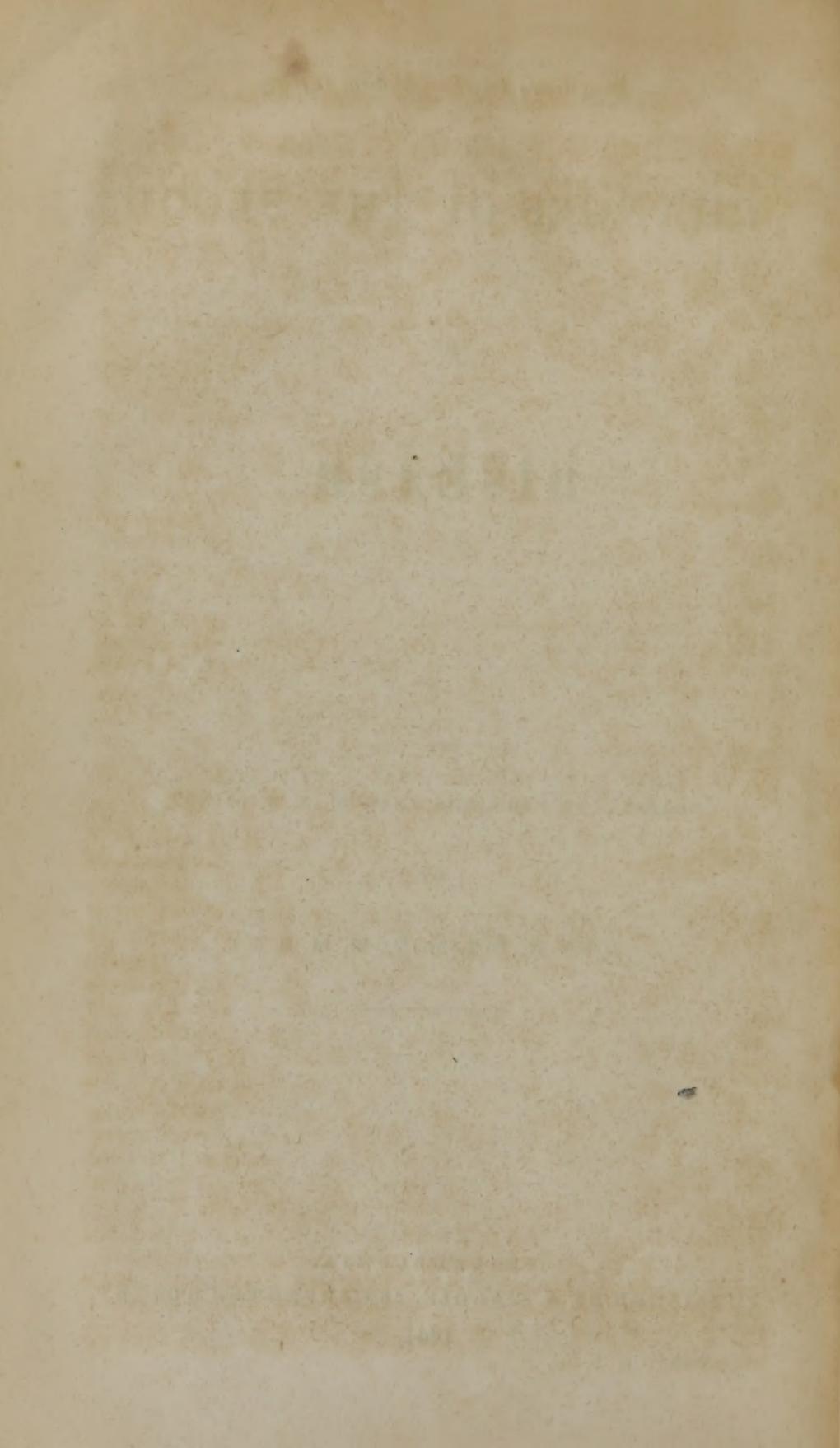
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# CHANGES OF THE BLOOD IN DISEASE.

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[The following Monograph was offered at the Concours for the chair of *Pathologie Interne* at the Faculty of Paris, at the time when M. Piorry was elected. The candidates were M. Piorry, M. C. Broussais, M. Dubois (d'Amiens) and M. Gibert.—ED. LIB.]

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The blood, this *soul of the flesh*, (Moses), this *treasure of life* (Ambroise Paré), this *liquid flesh* (Bordeu), this fluid, the source of all other fluids in the body, unceasingly moving in the process of circulation, unceasingly reanimated by the act of respiration, unceasingly changing, and unceasingly renewed by the act of nutrition, has always attracted the attention of observers, and most medical writers of different ages have assigned to it an important place in pathology. In our days, when exactness of methods derived from mechanics and chemistry enables us to study with minuteness the chief alterations in the blood, we find numerous investigations with regard to this fluid, both in its healthy and morbid conditions. A summary of these investigations, as concise and thorough as possible, will form the basis of this dissertation.

Passing over as very imperfect the chemical essays and microscopical observations of the savans of the seventeenth, and the early part of the eighteenth century, mentioned by Lecanu in his excellent memoir upon the blood, published in 1830, we would determine the constitution of the blood as it has been ascertained by the researches, experiments, and successive discoveries of Rouelle, Berzelius, Brande, Deyenx, (1804), Vauquelin, Chevreul, Prévost and Dumas, Lassaigne (1825), Raspail (1829), Lecanu (1830), Denis (1831), Müller (1832), and other physicians and chemists cotemporary with us.

Blood is a red fluid in the mammifera, birds, fishes, reptiles and annelida; colourless in the mollusca, crustacea, and arachnida, insects and zoophytes, and serves to nourish different parts of animals and contributes to the formation of products secreted by certain of their organs.

Studying the blood after it has been abstracted from the body, is really but making an autopsy of it, if we may be allowed so to speak, and the longer its examination is postponed after its abstraction, the less favourable will be the conditions for ascertaining its real nature, as entering into the composition of a living body. Many microscopical observations, and even chemical analyses have been erroneous from the necessity of studying these fluids after they have lost the characteristics of life.

M. Donné now renounces many of the results at which he had arrived by this common method, and confides only in those which he obtains after the plan of Mandl, which consists in observing the blood the moment it is extracted from the capillary vessels by means of a puncture.

By this new and more rigorous method, he has not met with those changes of the globules which he had at first announced in *typhoid fever*. After numerous researches, he has found but two cases in which the blood is essentially changed in its physical constitution. One of these cases was chlorosis, in which the number of sanguineous globules was evidently diminished, as M. Lecanu had ascertained by the ordinary method; the other an albuminous nephritis with dropsy, in which the mucous globules of the blood had become much more numerous, and the sanguineous ones much less so.

After the last very thorough experiments of Müller, (*Annales des sciences naturelles* 1832,) the blood must undoubtedly be considered as serum holding in solution fibrine, and in suspension globules containing the colouring matter and iron. The serum itself is but water holding in solution salts, (chloruret of sodium and potassium, subcarbonate of lime, magnesia and iron, &c.) albumen, and some other constituents less important, or whose existence is not admitted by all chemists, such as a fatty crystallizable matter discovered by M. Chevreul, an oily matter, extractive matters, osmazome, and perhaps cholesterine.

But before we proceed any farther, we must pause for a moment to consider the globules of the blood, which have been the subject of so much microscopical research,<sup>1</sup> from the seventeenth century

[For the translation of the notes to this treatise I am indebted to my friend Dr. J. F. W. Lane, of this city. J. H. D.]

<sup>1</sup> Malpighi records, in 1665, the discovery of the globules of the blood, (*De amento et adiposis ductibus, oper. omn.* London, 1686.)

Leuwenhoeck says, that he saw, for the first time, the globules of the blood on the 15th of August, 1673. He estimates their volume at the hundredth part of a grain of sand. (*Philos. trans.*, 1674, p. 23. 121; 1675, p. 380, &c.)

(Leuwenhoeck,) to the nineteenth, (Raspail, Donné, Müller and Mandl). We have said that these globules which contain the colouring matter are only suspended in the blood, and we have admitted, contrary to the opinion of almost all experimenters from Leuwenhoeck down to Lecanu, that these globules are distinct from the fibrine, which is to be considered as in a state of solution. Such is the opinion of Müller, adopted by M. Donné.<sup>1</sup>

Sénac (*Traité du cœur.* Paris, 1749. t. ii.) remarks that the circular globules of the blood are not spherical, but lenticular. According to him the globules become smaller in the scorbutic.

Fontana, (*Poison of the viper.* Florence, 1781,) says that the globules of the mammifera approach the globular form.

Spallanzani, (*Dell' azioni del cuore ne vasi sanguini.* Modena, 1768,) observed in salamanders globules of two forms, oblong and round.

Hewson, (*Philos. trans.* 1778, p. 303,) recognises the globules of the mammifera as lenticular. He admits an envelope and a nucleus; and that the globules are soluble in water, but not in serum, because of the salts it contains.

Prévost and Dumas (*Bibl. univ. de Genève,* 1821, t. xvii.) adopt the opinions of Hewson.

Raspail, (*Répert. d'anatomie,* t. iv. 1827. *Organic Chemistry,* 1838,) asserts that the globules of the blood must be considered as albumen originally dissolved in the serum, and afterwards precipitated from this menstruum.

<sup>1</sup> I owe to the kindness of Dr. Donné the following note, here inserted verbatim, although the rapidity of the *rédaction* has a little injured the methodical order.

"The blood must be considered as a liquid holding in solution albumen, several salts, and a peculiar characteristic principle, azotised, the fibrine, and in suspension solid particles of a complex structure; this theory results from the following experiment of Professor Müller, of Berlin. By filtration of the blood of a frog, the globules of which are so large that they do not traverse the paper, the liquid portion is separated colourless, in which we soon observe to be formed a clot of fibrine not coloured, the globules being retained by the filter. The clot is not then formed, as was formerly supposed, and as the theories of Prévost and Dumas support, by the globules; the fibrine is an element distinct from the globules; as is also proved, when the fibrine is separated from the blood by beating the latter with rods, for then all the globules are found intact in the coloured liquid. The weight of the globules must therefore necessarily be deducted from all calculations, in which the proportion of the elements is appreciated by the old theory of Prévost and Dumas, now adopted by Lecanu. Finally, the clot is formed by the spontaneous coagulation of the fibrine, as soon as it is freed from the vital action, and by imprisoning the globules in its meshes, like a sponge; this fact of the coagulation of the fibrine is inexplicable by the actual laws of physics and chemistry.

"The buffy coat is nothing but fibrine deprived of its globules; its formation is explained by admitting some cause to retard the coagulation, and afford the red globules time to be precipitated, and leave upon the surface a layer of colourless coagulable liquid. Blood possessed of this property does actually coagulate less rapidly than that which produces no buff. The proper blood-globules are red, circular, flat (lenticular), with an obscure point in their centre, in the mammifera; the only exception is a species nearly allied to the chamois, the alpaka (Mandl); in the three other classes, the globules are elliptical and always flat; the latter evidently contain a small solid nucleus which may be separated from the envelope; this nucleus has

When we look with a microscope through the membranous portions of the foot of a frog, the tail of a lizard, or the wing of a bat, all of which, from their transparency and extreme tenuity, are peculiarly adapted to this experiment, at the blood in circulation, we perceive that it consists of a fluid in which are floating distinct globules. These globules differ in form and dimension in different kinds of animals, and by means of these differences M. M. Dumas and Prévost (*Annales de chimie et de physique*, tome xviii. p. 280) have accounted for the failure of transfusion between individuals.

never been separated, nor distinctly perceived in the blood of the mammifera; I think its place is supplied by a liquid. Finally, the blood-globule, properly so called, is then a small vesicle containing the colouring matter and an albuminous element, liquid in the mammifera, and a solid nucleus in the three other classes; they are, moreover, soluble in water, ammonia, nitric acid, (those of the mammifera, this acid only contracting the solid nucleus of the others, and dissolving merely their envelope), insoluble in *nitric acid*.

"Independently of the blood-globules, properly so called, the blood contains two other kinds of globular particles, circulating with it in the vessels:

"1st. White globules, *spherical*, granular, entirely similar in their physical and chemical properties to the mucous globules as they are styled; soluble like the latter in ammonia, contracted by acetic acid, and I consider these globules as the products of the secretion of the vessels; I have found them in very great abundance in certain morbid states of the blood, among others, in an albuminuria. In the normal state their number is but small in comparison with the red globules of the blood, and the manner of seeing them is to separate them, to filter them, so to speak, by passing a drop of fresh blood by capillary attraction between two plates of glass; they have the property of adhering to the glass, while the blood-globules slide; they are seen in very great numbers in blood defibrinated and then left in repose; the red globules, being heavier, fall to the bottom, the white mucous globules unite to form a very thin layer upon the surface of the red layer, and the serum remains upon the superior part colourless. The microscope is necessary to analyse these three layers. This experiment, very applicable in clinical studies, is also the surest means of discovering small quantities of pus in the blood, the pus uniting thus by its weight to the surface of the red layer. Finally, there exists in the blood a third species of globular bodies, which are mere small white granulations analogous to those of the chyle. The red globules are  $\frac{1}{25}$  of a millimetre in diameter, the white  $\frac{1}{100}$ , and the granulations only about  $\frac{1}{50}$ . The origin, end, and use of the blood-globules are unknown. They are usually in proportion to the quantity of fibrine. The pathological alterations of the blood are of two kinds in a chemical point of view, strictly chemical (vide the thesis of Lecanu), or microscopic; the latter can only be discovered in the fresh blood, not yet coagulated, living, so to speak. Every observation made with this view upon the dead body, or even upon the blood in the cup, must be rejected; their effect is only upon the parts suspended in this liquid, in a word, upon the globules. I have found no appreciable alteration of the globules in typhoid fever, scrofula, pneumonia, phthisis, glanders, &c. In chlorosis I have found the globules more than usually transparent and destitute of colour, a great increase of the mucous globules in a case of albuminuria, and in one of anthrax in a female. The white blood has not been examined by the microscope.

"The globules of pus cannot in any manner be considered as modified blood-globules; they have different chemical and physical characters, and the transition from one to another has never been traced, &c."

viduals of different species, while it succeeds between individuals of the same species; a fact which is demonstrated upon man himself by recent observations published in England. It is true that in the observations which refer to the transfusion of venous blood from the veins of husbands to those of their wives who have become anæmic from uterine hemorrhage subsequent to delivery, the operation has been conducted with all the prudence, coolness and precaution likely to insure success. (See the *Archives générales de Médecine*, tom. ix. p. 565. xii. p. 290, et xviii, 437.)

The scientific are not agreed either as to the form or structure of the globules of blood in different animals. (Thèse de M. Martins, concours de l'agrégation, 1839.)

1st.—*Size.*—The diameter of the globules in man, which are among the smallest in the list, has been estimated between  $\frac{1}{15}$  of a line<sup>1</sup> and  $\frac{1}{50}$ .<sup>2</sup> The mean of the measures determined by observers since the year 1821, gives about  $\frac{1}{30}$  of a line. It should not be forgotten that the sanguineous globules of an animal are not all of the same size, and that therefore the taking of their mean is rational. The aquatic salamander has, of all the animals examined at present, the largest globules. Their large diameter is  $\frac{1}{5}$  of a millimetre according to MM. Dumas and Prévost,<sup>3</sup> and  $\frac{1}{6}$  of a millimetre according to M. Mandl, whose labours on this point are the latest.<sup>4</sup>

2d.—*Form.*—We now know that water changes the shape of the sanguineous globules by dissolving a part of their substance. If then we do not wish to examine the blood as it issues from the vessel which furnishes it, we must diffuse it in a solution of sub-carbonate of soda, sea salt, ammonia, sugar, or what is better, the serum of the blood of a frog filtered.<sup>5</sup> In all the mammifera the globules of blood are circular, except in the dromedary and the alpaca.<sup>6</sup> They are on the contrary elliptical in birds, reptiles and fishes. Though these general facts are admitted, there is a dispute as to the precise form of the globules. Let us look in the first place at the various opinions of authors as to those of the frog and salamander, which are most easily seen. To mention only the moderns, MM. Prévost and Dumas, Wagner,<sup>7</sup> Milne Edwards,<sup>8</sup> and Turpin, admit a central rotundity. Müller regards them as sensibly flat; finally, Young,<sup>9</sup> Hodgkin, and Lister,<sup>10</sup> and M. Du-jardin,<sup>11</sup> as slightly concave. It may be that all these appearances

<sup>1</sup> Leuwenhoeck, 1673.      <sup>2</sup> Della Torre, Epistola ad Hallerum, 1759.

<sup>3</sup> An Examination of the Blood and of its Action in the different phenomena of life. Bibl. Univ. de Genève, t. xvii. 1821.

<sup>4</sup> Memoir upon the Microscopical Parts of the Blood, 1838. p. 17.

<sup>5</sup> J. Müller, Handbuch der Physiologie des Menschen, t. i. p. 112.

<sup>6</sup> Mandl, Comptes rendus de l'Institut, 17th December, 1838.

<sup>7</sup> Zur vergleichenden Physiologie des Blutes, 1834.

<sup>8</sup> Bulletins Soc. Philomat., 14th January, 1837.

<sup>9</sup> Introduction to Medical Literature, 1813.

<sup>10</sup> Philosophical Magazine, 1827.

<sup>11</sup> Bull. Soc. Philomat. (loc. cit.)

are real; for it is probable that the globules become modified as soon as they leave the blood-vessels.

Have the globules of blood a central nucleus? There is the same discrepancy on this point. Some deny the existence of this nucleus in the living globule, and regard it as the product of the coagulation of the fibrine: as Blumenbach, de Blainville, Weber,<sup>1</sup> Wagner, Dujardin, Mandl and Donné.<sup>2</sup> This last goes farther yet; he considers the nucleus which unquestionably exists in the globules of the batracia as similar to that in the globules of the blood of man. Hewson,<sup>3</sup> Ev. Home,<sup>4</sup> Prévost and Dumas, as well as Müller, admit a central nucleus, to which the colouring matter serves as an envelope. The latter having poured some blood upon the object glass of a microscope of Frauenhofer, placed it in contact with a drop of acetic acid, and saw the colouring matter disappear; while still a colourless and very delicate outline marked the form of the sanguineous globule.

This experiment corroborated the idea of MM. Mandl and Donné, who admit that the colouring matter is merely deposited in the fabric of the globules. M. Turpin has shown me designs representing the globules of the blood of the frog magnified 260 times. The nucleus is sometimes central, and sometimes in the periphery, and is composed of granules, which can be separated from the globule by pressing it between two even layers of glass.

When we examine blood recently taken from a vein or artery, or better still, blood drawn from the capillary system by means of a puncture, (after the manner of M. Donné,) we find the fluid and its globules suspended in it as in the circulatory apparatus. It immediately begins, however, to separate itself into two parts; the upper, a liquid, of a slightly yellowish-green hue, called *serum*; the under, a solid of a beautiful red, called *cruor* or *coagulum*.

For a long time it has been admitted that the *serum* contained all the principles of the blood, with the exception of the fibrine and the colouring matter, which last combined, constituted the globules suspended in the serum. As the proportion of serum and of globules, supposed to be fibrinous, is not the same in all subjects and under all the different circumstances of age, sex, hygienic influences, health and disease; as, moreover, the form of the receiving vessel, the rapidity of the jet, the temperature, cause a more or less perfect separation of the serum and coagulum; so this proportion varies much in the admeasurements that have been made by different chemists. According to Sénac, the proportion of coagulum to serum would be as one to four, while other experimenters have found it as 1 to 1.66 only.

But the observations of M. M. Pierry and Scelles de Mondezert,

<sup>1</sup> Hildebrandt's Anatomie des Menschen, 1830.

<sup>2</sup> Recherches sur les globules du sang, thesis, No. 8, 1831.

<sup>3</sup> Experimental Inquiries. Philos. Trans. 1773.

<sup>4</sup> Philosophical Transactions, 1818.

Denis, Müller, have shaken the common opinion that the fibrine was only suspended in the blood and in conjunction with the globules: they have induced an opinion that the fibrine may during life constitute a part of the serum, be found dissolved in it separate from the globules. M. Piorry has remarked that if we remove carefully and quickly the serum as it collects on the surface of the coagulum, we often see it become turbid and soon covered with a superficial layer of fibrine.

The experiment of Müller is still more conclusive; he cut off the thigh of a frog, received the blood upon a filter moistened, that the very large globules might not pass through it, by mixing them in an equal quantity of sugared water, which is unsavourable to the solution of the colouring matter. The globules remained upon the filter, and the liquid which had passed through did not the less readily yield a fibrinous coagulum.

According to M. Donné, who adopted the results of the experiment of Müller, (*Thèse de la Faculté*, 1831), this coagulum is, in fact, fibrine, while the globules are but a kind of vesicle, or tissue containing albumen, and dyed with the ferruginous colouring matter, at least in the mammifera. It has been incorrectly said that these globules have a spheroidal form. In man they are lenticular, and accompanied by others of a different form, rounded and colourless, which are probably but mucus secreted by the parietes of the vessels, and designed to lubricate them.

According to M. Lecanu, the substances contained in the blood taken from the veins at the bend of the arm are twenty-seven, viz. free oxygen, free azote, free carbonic acid, extractive or indeterminate substances, hydrochlorate of soda, hydrochlorate of potash, hydrochlorate of ammonia, sulphate of potash, carbonate of soda, carbonate of lime, carbonate of magnesia, phosphate of soda, phosphate of lime, phosphate of magnesia, lactate of soda, soap with a base of soda, and fixed fatty acids, a volatile odorous salt from a fatty acid, a fatty phosphorescent matter, cholesterine, seroline, free oleic acid, free margaric acid, fibrine, albumen, a yellow colouring matter, a red colouring principle, and water.

With regard to the relative proportions of these principles, the estimates of modern chemists lead upon the whole to consider the venous blood of man, as represented by the number 1000, thus, of

Serum	869.1547
Globules (fibrine included)	130.8453
	1000.

Or of,

Water,	790.3707
Water, oxygen, azote, carbonic acid, extractive matters, phosphoretted fat, cholesterine, free oleic acid, free margaric acid, hydrochlorate of soda, hydrochlorate of potash, hydrochlo- rate of ammonia, carbonate of soda, carbonate of lime, carbonate of magnesia, phosphates of soda, lime, and magnesia, sulphate of potash, lactate of soda, salt of fixed fatty acids, salt of volatile fatty acid, yellow colouring matter.	10.9800
Albumen,	67.8040
Globules, (fibrine included,) . . . . .	130.8453
	1000.

The globules themselves, according to M. Lecanu, give the following proportions of the three materials contained in them:

Fibrine,	2.9480
Hæmatosine,	2.2700
Albumen,	125.6273
	130.8453

We would add that M. Denis, of Commercy, (*Essai sur l'application de la chimie à l'étude physiologique du sang de l'homme*, 1 vol. Paris, 1838,) seeks to demonstrate that fibrine is only albumen in a peculiar condition, an opinion adopted by M. Raspail, who thinks that fibrine is nothing but insoluble albumen united to certain salts. M. Lecanu himself admits that it is very difficult, not to say impossible, to distinguish fibrine from coagulated albumen.

As to the whole quantity of blood contained in the human body, Fr. Hoffmann and Quesnay estimate it to weigh fifteen kilogrammes;<sup>1</sup> other experimenters have made larger and smaller estimates; it being, in fact, impossible to estimate it exactly.

Chemistry, on the contrary, enables us to ascertain the relative proportions of the different components of the blood, and the numerous researches of MM. Lecanu, Denis, Prévost and Dumas, have made known the variations in this proportion, according to sex, age, temperament, kinds of food; the results of which do but give a scientific confirmation to opinions already prevailing from the light of observation and common experience. We will enumerate concisely from M. Lecanu, some of these results.

The proportion of water is smaller in the blood of man than of woman. The proportion of albumen is the same.

The proportion of globules is greater in the blood of man than of woman. It is also greater in the blood of sanguineous persons

<sup>1</sup> One kilogramme is equal to 2 lb. 8 oz. 1 dr. 24 gr.—Translator.

than in that of lymphatic persons of the same sex. The proportion of water is greater in the latter. The proportion of albumen is nearly the same.

The proportion of water is less, and that of the globules greater in persons well fed, than in those who are scantily, or ill fed.

In fine, the proportion of globules would seem to indicate the amount of vital energy.

This general result is of great importance, since MM. Prévost and Dunant have taught us how essentially different is the action of the serum and of the globules upon the nervous system, the former hardly stimulating it at all, and the latter stimulating it powerfully.

By a remarkable coincidence every cause which diminishes the mass of the blood seems also to lessen the relative proportion of globules, by increasing that of the water, so that these causes result in depleting the blood vessels, and impoverishing, or rendering fluid the blood which they contain. In women, uterine evacuations—in both sexes, bloodletting and the use of dry diet—produce always this twofold effect.

The rapidity with which it is brought about by bloodletting, for example, is remarkable; thus, according to the author whom we quote, the blood of a robust young man of twenty-three years of age gave:

This rapid diminution of the globules results from the fact that the veins absorb, at the expense of the rest of the system, a quantity of non-sanguineous fluid, proportional, and perhaps equivalent, to that which the blood in circulation has lost, whence the advantage of bloodletting when it is desirable to promote absorption, and also in certain dropsical affections.

On the other hand, according to M. Denis, watery drinks seem to diminish very slightly the proportion of globules, while they increase that of the water.

Thus in the blood of a young man twenty-one years of age, were found :

Water,	.	.	.	.	.	.	.	770
Globules,	:	:	:	:	:	:	:	154
Albumen, &c.	:	:	:	:	:	:	:	76
								—
								1000

And after forty days use of watery drinks :

Water,	.	.	.	.	.	.	.	804
Globules,	:	:	:	:	:	:	:	111.9
Albumen, &c.	:	:	:	:	:	:	:	84.1
								—
								1000.

But the diet alone to which the young man was subjected at the same time, might have produced a similar effect.

We would still follow M. Lecanu in stating the differences which mark venous and arterial blood, differences important to be observed on this occasion, though in pathology one is rarely concerned except with the venous blood, or at most incidentally with the capillary.

The arterial blood is of a more vermillion redness, and has a more decided odour than the venous blood; it seems to have a greater tendency to coagulate, which indicates a larger proportion of globules; and to yield a fuller, firmer coagulum, and therefore a less quantity of serum, which also is an indication of a larger proportion of globules. It seems to contain proportionally less of water and more fixed material, the idea of which implies greater density.

More globules and fibrine, a quantity of albumen and of extractive, saline and fatty matters, about equal; more of oxygen proportionally to its carbonic acid; less of carbon, and more of oxygen in combination. These two last circumstances correspond with the commonly received theories of the phenomena of respiration.

M. Denis, contrary to the opinion advanced by Dr. Pallas, (*Journal de Chimie*, t. iv. p. 465,) proves that the blood which we extract from the capillary vessels by cupping partakes more or less of the qualities of arterial or venous blood, according to the predominance of arteries or veins in the neighbourhood of the part selected, and demonstrates, that in chemical analysis the blood of the capillaries does not differ from that of the arteries and the veins. We are, nevertheless, inclined to think that the blood in this state of transition from arterial to venous blood, differs sensibly from both; but that the differences depend as much upon the nature of the principles as upon their number or their proportion.

#### ALTERATIONS OF THE BLOOD.

The blood may undergo alterations as to *quantity* and *quality*; its density, colour, temperature, the proportion of its components

may vary; besides which, it may contain foreign substances, either generated in the system itself, or introduced from without. Thus the yellow matter of bile has been detected in the blood of jaundiced persons, by MM. Orfila, Clarion, Lassaigne, Lecanu; urea has been recognised, after the removal of the kidneys, by MM. Prévost, Dumas, Vauquelin, Ségalas. Fatty matters have been found suspended in the blood (*milk* blood of authors), pus, (phlebitis and purulent absorption,) and some other morbid products.

Bichat, (*Anat. génér.* preface,) has found the blood sanious; M. Andral, has seen it like lees of wine; MM. Breschet and Andral have observed acephalocysts in the veins; M. Breschet has found melanosis; M. Velpeau, has met with medullary matter in a coagulum of blood. Miasms and virus, undoubtedly, infect the blood before producing their pathological symptoms. Many substances introduced by means of the alimentary canal, or injected directly into the veins, temporarily change it.

M. Ségalas (*Archives gén. de médec.*, 1826, t. xii.) has injected pure alcohol into the veins of many dogs, and has given, in a paper read by him to the Academy of Medicine, these results from his experiments: first, that alcoholic intoxication is connected with the presence of alcohol in the blood; second, that the phenomena which accompany it are owing to the abnormal action of the blood thus modified, upon the organs, and especially upon the nervous system, and that these phenomena are the effect of the alteration of the blood. In the same memoir are related some experiments of injecting into the veins an alcoholic extract of *nux vomica*, which occasions tetanic accidents plainly arising from the presence of poison in the blood. MM. Leuret, Troussseau, and Dupuy, in the eleventh volume of the journal now quoted, M. Gaspard, in the *Journal de Physiologie Expérimentale*, (ann. 1822, 1824,) have injected into the veins of animals, or inserted in the cellular tissue, virulent putrid, or purulent matter, such as blood taken from a carbuncled animal, water in which a muscle has macerated, the pus of a carbuncle, &c., and they have seen symptoms developed like those of putrid fever, very evidently the consequences of infection of the blood. It is important to observe in the experiments of MM. Troussseau and Dupuy, that the pus of a scrofulous cyst injected into the veins has caused subcutaneous deposites evidently eliminatory, and accompanied by little nervous disorder, while the putrid water from a macerated muscle has induced typhoid symptoms, with serious lesions of the organs of digestion and respiration, followed by death.<sup>1</sup>

<sup>1</sup> M. Delafond, professor in the veterinary school at Alfort, in a memoir before the academy upon the essential alterations of the blood in animals, considers in succession the alterations of the blood, which consist in an increase or diminution of the quantity of this liquid, *polyæmia* and *anæmia*; those in which there is an alteration of the globules, *diaræmia* and *diastæmia*; finally, those characterised by its incoagulability, black colour, its septic properties, *meloæmia*.

Taking up the subject rather as a practical physician, than as an experimenter, I shall consider the alterations of the blood only under the heads of the diseases in which they are observed (sometimes, indeed, they are only suspected,) and, running rapidly through the table of nosology, we will begin by mentioning those affections in which the alteration of the blood seems to be really the source of the morbid phenomena, or at least seems to play an important part in the disease.

In polyæmia, plethora, the quantity of the globules is greater than in the normal state, and the mass of the liquid is too abundant. It often occasions sanguineous effusions, or merely congestions of different organs; the consequent apoplexies are with difficulty distinguished from those produced by other causes. A nutrition too abundant, or capable by its nature of diminishing the relative quantities of serum and albumen, by causing the fibrine to predominate, is the most common cause of this alteration. In anæmia, on the contrary, there is a diminution in the quantity of the blood, and impoverishment of its elements; drawn from the jugular, this liquid issues in thin jets, and coagulates slowly. The nutritious aliments, corn, wheat, &c. are especially indicated; bark, and, above all the preparations of iron, are the medicines required. In hydroæmia, more frequent in England than elsewhere, the serous elements predominate over the coagulum, without any diminution of the quantity of the blood; nevertheless, the analogy between it and anæmia is great. The animal is easily put out of breath; the heart beats with violence, &c.; drop-sy, serous diarrhœas arise; entozoa are developed in the intestines, and liver. In these cases the animals must be induced to emigrate, good food be given; the leaves of green trees, pine, spruce, the preparations of iron produce good effects. In diaræmia, a common malady in woolly beasts, the blood-globules are diminished in quantity; the blood becomes more thin; it permeates the walls of the vessels into the interior of the cavities; the same phenomenon takes place in diastasæmia, characterised by the separation of the elements, which constitute the globules, the fibrine and the albumen disunited from the colouring matter; the fibrine attaches itself to the valves of the heart. To this alteration correspond as secondary lesions, certain local affections, gangrenous coryza, a variety of anthrax: diastasæmia may be acute or chronic. Venesection, the administration of the *Eau de Rabel*, appear to agree in this variety of alteration of the blood.

In meloæmia there is a septic modification of this liquid, which takes upon itself properties essentially deleterious; to this class correspond all the septic carbuncular diseases, which the blood may develop in other individuals by inoculation or contact with certain surfaces. M. Delafond studies to this end the contagion of the carbuncular affections, and the other causes of this alteration of the blood. According to him, the blood constitutes a real virus. The majority of the organs, the liver, spleen, lungs, in the animals which succumb almost always with great rapidity, contain a black, ropy, pitchy blood, staining the fingers and the walls of the vessels, diffusing an infectious odour after a few moments in the open air; on washing, it furnishes small clots of fibrine, giving birth in the organs to extensive black effusions, and upon the surface to tumours of the character of anthrax. The incision of these tumours, their deep cauterisation, seem to M. Delafond absolutely necessary; action must be immediate, for the progress of this terrible affection is most rapid when once developed.

The author then examines comparatively the diseases produced in man by the essential alterations of the blood; he finds the greatest resemblance between them and those investigated in animals.

It will be impossible to escape all blunders and omissions in a subject so vast and as yet so obscure, but we will attempt at least to exhibit its principal points, acknowledging our inability to resolve problems which would require for their solution deep and undivided attention for a long time.

SECTION I.—1st. ANEMIA. In the description given by the celebrated Hallé of the disease observed among the labourers in the mine at Anzin, (See vol. vi. 1803, of the *Bibliothèque Médicale*,) the most remarkable symptoms were a blanching of the whole surface of the body, a wan yellowish tint, not only of the skin, but also of the conjunctiva, the inner side of the lids, the interior of the lips and of the mouth, and of the tongue itself. No ramifying of capillary vessels upon the conjunctiva or the gums, no vein apparent upon the arm, fore-arm, or back of the hand. At the autopsy there proved to be a general deficiency of blood, and an universal palleness of all the parts naturally red. The treatment which succeeded best was the use of chalybeate tonics.

This anemia was attributed to the residence of the workmen in a subterranean gallery, where the ventilation was imperfect. The temperature being there at seventeen degrees, respiration was impeded, and the water which trickled through the mine exhaled an odour of sulphuretted hydrogen. The invalids having pain in the abdomen it was at first supposed that the disease was analogous to the painter's colic; but the treatment prescribed under this impression proved unsuccessful.

Syncope is one of the most common accidents in this condition. In the anemia which follows quickly upon hemorrhage, it is evidently intended to obviate the danger, by stopping the course of the blood. It may in other cases become itself the cause of death when it is extreme, or prolonged. We have seen during the last year at the hospital de l'Oursine, a woman die suddenly of syncope, who had a considerable embonpoint, and no other pathological condition either in life or death, except a marked anemia. The report ascribed it to repeated hemorrhages from the anus, with the concurrence of other debilitating causes. There was still to be seen at the margin of the anus a flaccid hemorrhoidal ring.

In my memoir on the use of general and local bloodletting, (see vol. ii. 1826, of the *Bibliothèque Médicale*,) I have reported a remarkable instance of anemia from loss of blood in consequence of repeated applications of leeches.

M. Piorry (*Maladies du Sang.*, 1836,) has given a very minute description of anemia, and, at the same time, a very correct theory of syncope.

M. Andral, (*Anatomie Pathologique*, tom. i.) has seen a general anemia supervene without any appreciable cause. He has ascertained the existence of it in some dropsical persons at a post mortem examination, in whom, in other respects, no alteration of the solids was cognisable by our modes of investigation.

2. Dr. Jolly, in a paper lately published on this disease (see the

*Revue Médicale* for December, 1839,) proves, that the blood of chlorotic persons is partly deprived of its colouring principle; that its cruoric or fibrinous part is more or less diminished, and its serous or albuminous more or less predominant. In the usual state the serum is to the coagulum as three to eight; but in anæmia and chlorosis, the proportion of serum exceeds seven tenths of the whole mass of the blood.

M. Jolly has seen one case in which it constituted almost nine tenths. This excess of the serous part of the blood, together with its greater fluidity, explains the opaline transparency and œdematos condition of the skin, as well as the inactive state of all the organic tissues. M. Delafond, professor at the school of Alfort, has shown, that in the aqueous cachexy, of the veterinary practitioners, a condition analogous to the chlorosis of the human species, the blood is frequently reduced to a third or quarter of its normal quantity. Hence probably the bruit de souffle, which is noticed even in the arteries of the extremities.

An analysis, by M. Lecanu, of the blood of a young chlorotic person, who had for several days been labouring under an attack of pleurisy gives the following results:

Water,	862.40
Albumen, &c.	82.45
Globules,	55.15

(instead of 115 the mean quantity, or 68, which is the minimum.)

This marked diminution of the globules of the blood (by which are understood in the analysis of M. Lecanu to be embraced the fibrine and colouring matter of the blood,) accounts for the want of colour, and the diminution of the quantity, consistency and plasticity of the blood in chlorosis. According to M. Jolly, it is not merely to the presence or absence of the iron, that the deeper or lighter colour of the blood is to be attributed, for on the one hand, chemistry has not demonstrated the certainty of this relation, and on the other, iron, so useful in other respects as an antichloretic, does not seem to be absorbed, but appears in the same quantity in the egesta as in the ingesta of invalids to whom it has been administered. M. Delens, attributing to the sanguineous globules vital properties, thinks that in the treatment of anæmia and chlorosis, the iron acts neither upon the chemical composition of the blood, nor upon the nervous system, but upon the vitality of the globules.

M. Jolly, on the contrary, refers the anæmic condition in chlorosis to the impaired nervous energy of the ganglionic system.

He is induced also to regard the *painter's colic* (in which in fact a sort of chlorotic condition is observed,) as a peculiar form of anæmia, owing to a poisonous influence by which the vitality of the ganglionic system is depressed, and the treatment of which demands the elimination of the agent which has produced it.

We all know, without having recourse to chemical analysis, that in true chlorosis the blood is pale, serous, hardly staining linen, scarcely susceptible of coagulation, in short, that it is *impoverished*.

SEC. II.—WHITE CACHEXY, (*Scrofula, Dropsy, Albuminuria, Diabetes.*) In the memoir which we have quoted, M. Jolly compares to chlorosis and anæmia the *watery cachexy* of veterinary physicians, which appears endemically in marshy and damp regions, where intermittent fever is common, as at Sologue. The damp, marshy atmosphere produces in man similar effects. It is well known, that in countries where intermittent fever is endemic, a large part of the population is in an anæmic state, and has a tendency to a true watery cachexy.

Similar causes, especially the privation of the sun's rays, together with want of exercise, cause in many animals domesticated in our house or in menageries, a state of anæmic debility which renders the white fluids of the body predominant, and leads to the development of tuberculous cachexy.

M. Baudelocque, in his Researches on Scrofula, has considered as the proximate cause of scrofulous affections, an essential change in the sanguineous system in consequence of deleterious qualities of the atmosphere. This cause, he says, exists wherever scrofula is found, and where it does not exist, scrofulous diseases are unknown. If sufficient importance has not been attributed to this cause, it is because we have rested satisfied with other circumstances calculated to develope this evil, or because we have entirely neglected to ascertain the condition of atmosphere in which a great part of the day, and the whole of the night is passed. (See the *Revue Médicale*, 1834, t. iv. p. 127.) Chemistry has not hitherto discovered any sensible alteration of the blood in scrofulous persons. M. Dubois, of Amiens, thinks that he has discovered by microscopical observations an alteration of the globules, a lessening of the coagulability and variations in the colour of the blood of scrofulous persons. M. Donné, on the other hand, finds no appreciable differences between the blood of scrofulous and other subjects.

Fred. Hoffman, (*Méd. rat. syst.* t. iv. p. 4, p. 430, Ed. Francf. 1738,) treating of *dropsy*, attributes it solely to an embarrassment of the venous circulation. Scarcely, says he, can any one in my opinion find any other cause of dropsy, than the hindrance or difficulty of the circulation of the blood in the veins stopped, or retarded by various causes. He relies upon the celebrated experiments of Lower, (*de Corde*, cap. ii. p. 123. 1669,) who produced dropsy in animals by putting a ligature on the large venous trunks. The necroscopic observations of M. Bouillaud, (see vol. ii. p. 188, of the *Archives générales de Med.* 1823,) revived this ancient opinion which had been lost sight of since the physiologists of Bichat's school made the absorbent vessels an appendage of the lymphatic system. Fully admitting the reality of this cause, it is not to be considered as the only one, and must frequently be regarded as only secondary. Thus many authors, from Erasistratus, the celebrated anatomist of the school of Alexandria, down to M. Andral, have found in a lesion of the liver (itself an obstruction to the abdominal venous circulation) the cause of ascites. In our own day a peculiar change

of the kidneys is regarded as the cause of many cases of dropsy, Still it must be conceded, that an obstruction of the circulation is the most frequent source of dropsies, and that some even seem to depend upon an excess of the watery portion of the blood. With this condition of the fluids is usually connected a debilitated state of the solids. This is seen in chlorosis, anaemia, and true watery cachexy.

The experiments of Hales (*Hæmost.* Exp. xiv. to xx.) have shown, that water forced into the arteries instead of returning freely by the veins, finds its way into the cellular tissues and serous cavities. Dropsy is readily induced by large and repeated bloodlettings. Evacuating the serum of the blood by frequent drastic purgatives, empirics relieve certain cases of dropsy, &c.

M. Andral (*Clinique médicale*, tom. i. 1829. 2d ed.) has summed up in the following manner the phenomena which supervene in animals, whose veins have been injected with a certain quantity of water. For a short time after the injection a decided effect is produced on the brain; they remain motionless, depressed; their gait is unsteady. At the same time, and even more uniformly, their respiration is quickened, and they pant as after a long run; but very soon the urine and the exhalations from the lungs become abundant. By means of these salutary evacuations the system rids itself of the artificial increase of its circulating fluids, and the animal speedily recovers its health. If the injection of water is continued, the most serious effects are produced, the lungs are more and more engorged, and death from a sort of asphyxia supervenes. Upon examining the subject after death are found: first, the lungs filled with a large quantity of spumous serosity; second, aqueous effusions commencing in the different serous cavities. M. Andral adds, that he has often witnessed a similar train of symptoms in dropsical persons, when the serous effusion has disappeared without the establishment of a depletive and eliminatory evacuation. Thus, without any new appreciable lesion of any organ, without any known cause, during and after the sudden disappearance of a dropsical effusion, the invalids become suddenly depressed, their understanding is enfeebled, their sensations benumbed, respiration becomes laboured, tracheal râle ensues, and they quickly die in a state of asphyxia. In such cases, the pulmonary apparatus is found to be engorged with a colourless spumous serosity.

The sudden resorption of serous congestions, without a vicarious evacuation, is not in some cases followed by so grave results as we have named. May it not be, that in these cases the vascular system, containing but little blood, receives without injury an increase of fluid. Thus, if previous to the injection of water into the veins the animal has been largely bled, the accidents we have spoken of do not occur.

M. Andral recognises, moreover, the existence of an idiopathic dropsy. He cites (p. 143 of volume last referred to) five cases of hydrothorax without any appreciable organic lesion, the hydro-

thorax occurring of itself, or having been preceded by ascites or anasarca. He refers even to idiopathic dropsy, that which frequently appears as a sequence of scarlatina. In seven examples of this kind of dropsy, the dropsy commenced sometimes in the face, in the lower extremities of some, and in the abdomen of others. In two cases there was anasarca alone, in the five others there were at the same time anasarca and ascites.

Finally, the author enumerates many other instances of idiopathic dropsy occurring under different circumstances, cases in which the examination of the patient during life, and of the body after death, did not lead to any essential lesion that could be considered the cause of the dropsy. At one of these autopsies there appeared an anaemic condition so complete and universal, that the subject might be supposed to have died of hemorrhage. It was, indeed, an example of that sort of watery cachexy which some modern authors have proposed to call hydroæmia. In this cachectic condition, the blood loses its colouring material, and the proportion of fibrine is so much diminished, that the blood does not coagulate. If leeches are applied to the skin in this state, there flows from the bites a true reddish serosity. If we bleed, a nearly colourless watery liquid issues, which scarcely stains linen. This is a fact which we have often witnessed in chlorotic amenorrhœa.

In albuminuria (albuminous nephritis in a chronic form) which has lately been considered as allied to a peculiar form of dropsy, (see vol. ii. of *Traité des maladies des reins*, by M. Rayer,) the blood appears to be in the same impoverished state. Examined by the microscope, the red globules of the blood appear less numerous than in the healthy state; and there may be seen a few white globules larger than the others. The proportion of serum is increased, that of the crux diminished; the proportion of albumen contained in the serum is also diminished. M. Rayer has seen the density of the serum reduced to 1013, which, according to Gregory, is usually 1028. When the serum is treated with nitrid acid it forms a sort of grayish, diffluent gelatiniform magma.

It has frequently a milky aspect. In dropsy with coagulable urine (albuminous), diabetes, and some other urinary diseases, the blood sometimes contains, in fact, an anomalous quantity of fatty material which may give it a milky appearance.

Notwithstanding the unsuccessful researches of many chemists,<sup>1</sup> it appears that a certain quantity of urea may sometimes be obtained from the blood in albuminuria; at least Christison has obtained it (see vol. i. p. 110. 231, and vol. ii. p. 123 of the work of M. Rayer.) It appears, also, that Nysten and Barruel have discovered a certain quantity of urea in the serosity effused into the abdomen of a dropsical person.

In acute albuminous nephritis, the blood, while assuming the

<sup>1</sup> M. Lecanu did not succeed in discovering urea in the blood of two subjects with albuminuria which he analysed.

qualities of inflammatory blood, still retains some of those just mentioned. Thus the serum is sometimes milky, owing to the presence of a fatty matter, which may be isolated by means of sulphuric ether. The albumen passes from the blood into the urine and the specific gravity of the serum diminishes, together with its coagulability by heat and nitric acid.

In two analyses, which M. Rayer has made in conjunction with M. Guibourt, he has not been able to obtain urea from the blood, by the ordinary methods, but nevertheless it seems, that in some cases, where the urinary secretion is very much changed, the blood does become charged with urea.

M. Rayer quotes upon this point an observation of Christison, which proves, that urea may exist very early in the blood of persons attacked with this malady. On the ninth day of an anasarca with coagulable urine, occurring in a man who had had previously two attacks of dropsy (one twenty years, the other only five before the attack observed by M. Christison), there was already a diminution of thirty-five per cent. in the proportion of albumen in the blood. The blood contained a considerable quantity of urea, and the serum was slightly lactescent.

But on the other hand, the blood extracted from a vein at the commencement of acute albuminous nephritis is almost always buffed, and sometimes so that the coagulum assumes the appearance of a mushroom.

M. Rayer has seen the specific gravity of the serum increased some days after an emission of blood, while in consequence of this emission the urine became less albuminous.

In diabetes the blood is generally impoverished. The result of the experiments of Nicolas and Gueudeville, of MM. Soubeiran and Henry is, that the blood of diabetic persons furnishes more serum, less of coagulum, and less of fibrine, than the blood in a normal state. M. Bouchardat (*mémoire on diabetes*, in the *Revue Médicale* for June, 1839,) has confirmed these results by a new analysis. He found in the blood of a diabetic person,

Albumen,	.	.	.	.	.	.	62.54
Fibrine,	.	.	.	.	.	.	1.95
Globules,	.	.	.	.	.	.	118.23
Salts, extractive matter, &c.	.	.	.	.	.	.	8.52
Water,	.	.	.	.	.	.	808.76
							1000.

Rollo, in his *Treatise upon Diabetes*, published at London, 1797, had announced, that the blood of diabetic persons contained a portion of sugar. This has been contradicted by Nicolas and Gueudeville, (*Annales de Chimie*, t. xliv.) and since by many other authors. M. Bouchardat thinks that these contradictory results are to be accounted for from the urine not having been analysed under the same circumstances. According to him, this

liquid contains an appreciable quantity of sugar, but only for two hours following a meal. We will quote the words of this writer.

"The true cause of these discrepancies, says he, has been revealed to me by two comparative analyses effected under different conditions. The first was from an invalid, who was bled at nine o'clock in the morning, and who had not eaten since five o'clock of the evening before. In this case, no trace of sugar was discoverable. The second was an invalid, who was bled two hours after a light meal, and in this case there were unequivocal signs of the presence of sugar in the blood. The process was as follows: ten ounces of blood were evaporated to solidity upon a salt-water bath, the solid products were many times treated with alcohol at 30°. The alcoholic solutions were evaporated, the residuum taken up by water, and the liquor filtered. I conducted a similar process upon the same quantity of blood taken from a healthy man.

I added in the two cases the same quantity of yeast; fermentation took place very sensibly in the blood of the diabetic patient, but not apparently in the blood of the healthy man. Yet I must say, that, like M. Guibourt, I could not obtain an appreciable quantity of alcohol. But it should be observed, that the quantity of blood on which I operated was very small, and that the repast which the invalid had taken was very slight. Thus in my opinion the question is decided; the kidney is but an organ of elimination; its office in diabetes is to eliminate the sugar from the blood, as it is in health to eliminate the urea." According to the theory of M. Bonchardat, the sugar is formed in the stomach by the action of principles contained in it upon feculent articles of food. In order that this transformation may take place, the quantity of water in the stomach must be seven times greater than that of the fecula, and he has also remarked, that the thirst of diabetic persons is in direct proportion to the saccharine or feculent food which they take.

This chemical theory is not more satisfactory than the many other purely chemical theories, which at various periods it has been attempted to force into systems of pathology.

The experiment as to the existence of sugar in the diabetic blood which is designed to support it, is hardly conclusive, and if it were so, would not be decisive, for sugar has been found also in the blood of a healthy man. (Buss:—Thesis at the concours of 1838, upon *alterations in the urine*.)

An essay in German by M. Marchand, reviewed in the *Journal de Pharmacie*, 1838, makes mention of the experiment (to us a little doubtful) of Ambrosiani, an Italian chemist, who after many weeks succeeded in obtaining nine grains of sugar in crystals from a certain quantity of blood taken by the lancet from a diabetic patient. The same essay contains some researches upon urea, which the author has not been able to discover in the blood, except in the case of forced suspension of the venal secretion already mentioned by Prévost and Dumas; in order to effect which, if this author is to be believed, it is not necessary to extirpate the kidneys,

but merely to put a ligature on the nerves, which supply these organs.

According to M. Rayer, (*Maladies des reins*, t. i. p. 243,) it has been said, that phosphate of lime was in excess in the blood of diabetic persons. There has been a greater disposition to search in it for sugar, because the kidneys present after death no remarkable alterations aside from their hypertrophy. A new experiment of *MacGregor*, (Lond. Med. Gaz. vol. xx. p. 271,) has confirmed the results obtained by Maitland, as to the existence of sugar in the blood of diabetic persons. A diabetic person was bled seven times, a pound each time, at intervals of three days; the whole amount collected furnished a serum of a milky appearance, of a specific gravity of 1033; it was coagulated by heat and completely dried in a salt-water bath; the coagulum was afterwards boiled in water after having been carefully divided; the liquor filtered and concentrated by evaporation, fermented strongly many hours by the addition of yeast. But does this fermentation suffice to prove the existence of sugar?

SEC. III.—FLUX, (*Cholera, Hemorrhages, Scurvy.*) Contrary to the hypothesis advanced by a physician of the North, chemical analyses have demonstrated, that the blood in *cholera* retains its normal alkalinity. But its qualities are still very essentially altered, as the analyses of MM. Young and Rayer (*Journale de Chimie Medicale*, t. viii. p. 542,) those of MM. Lassaigne, Lecanu, and many others in and out of France have demonstrated. Common observation had already recognised this alteration. Thus every body knows, that in the epidemic cholera which prevailed at Paris in 1832 the blood was so viscous and destitute of serum, that it would hardly flow from an opened vein during the cold period, and that upon the dead body it was like currant jelly, instead of being separated into serum and coagulum. Chemical analysis has proved a less proportion of water, fibrine, and alkaline salts in the blood in cholera. M. Lecanu has found it composed of

Fixed matters,	.	340	Instead of fixed matters,	221.4
Water,	.	660	Water,	778.6
		1000		1000.0

Two months before the prevalence of cholera at Paris, the blood of a person who had sunk with symptoms of this disease, gave the following results :—

Fixed matters,	.	.	.	.	.	.	.	139.5
Water,	.	.	.	.	.	.	.	760.5

M. Lecanu had directed the attention of physicians to this fact, which was still more remarkably apparent two months later, at the time of the death of Marshal Lobau's cook, the first authentic victim of cholera. The blood of this subject gave a greater proportion still of fixed matters, as the following numbers show :—

Fixed matters,	:	:	:	:	:	330
Water,	:	:	:	:	:	670
						1000

The serum and the alkaline salts which are deficient in the blood, are found in the evacuations in cholera which are sensibly alkaline and albuminous; and this circumstance explains the fact, that in this disease, grave adynamic symptoms coexist with a state of the blood analogous to that of plethora and inflammatory diseases. This remark should be well considered by those physicians who are too much disposed to avail themselves of chemical analysis in pathology; it shows indeed how indispensable it is, that chemical analysis should be relied on only so far as they accord with the results furnished by the more certain and common modes of investigation. In cholera the analysis of the blood taken by itself would evidently lead to dangerous errors as to the nature and treatment of the disease. Chemical views have lead some experimenters to propose the use of alkaline solutions, either in drink or in injections into the veins, in order to restore to the blood what it had lost. MM. Dumas and Prévost have demonstrated long ago, that by adding to the blood 1.1000 of its weight of carbonate of potash or soda, it loses its power of coagulating.<sup>1</sup>

It is known, that in cholera the secretion of urine is sometimes suspended for several days. Two foreign chemists quoted by M. Rayer, (Marchaud and O'Shaughnessy,) say, that they have, under such circumstances, found urea in the blood.

M. Fry, in the presence of several physicians associated with him at the hospital of Joladoff, in Poland, inoculated himself on the inner side of the left arm with the blood of a patient just about to die of cholera. The day before he tasted matter vomited by a person labouring under the disease. These two bold experiments produced but a slight irritation of the skin. (Letter to the Institute. See the *Revue Médicale* 1831, vol. iii. p. 123.)

Hemorrhages seem to depend in many cases upon a peculiar state of the blood, analogous sometimes to that which is observed in plethora of which we shall speak hereafter, and sometimes to that which is met with in scurvy, which we are about to consider. But what is the condition of the blood which causes the disease described in works upon cutaneous diseases under the name of *purpura*?

In accordance with M. Rayer, (*Traité des malad. de la peau*,

<sup>1</sup> According to M. Magendie (t. iv. p. 135 of his *Lectures*,) the English pretend to have injected with success into the veins of several persons with cholera, an artificial serum. M. Magendie has obtained no advantage from similar injections, made, it is true, in desperate cases, with a serum composed of water, albumen, and salts of the blood. The author has remarked, however, that the injection of human serum into the veins of a dog is followed by the gravest consequences, and that the serum of the same species even causes accidents and acute pains, analogous to those of rheumatism.

t. iii. p. 522.) Aaskow, having analysed the blood of persons affected with purpura, asserts, that it differs in no respect from that of a healthy person. Johnston, however, has seen the blood after a venesection remain liquid and not separated into serum and coagulum, although it showed some traces of coagulable lymph. In one case observed by Duncan, the blood while issuing from the vein had an extraordinary appearance, not unlike arterial blood mixed with matter, its colour was of a lively red, and it had a sort of semi-transparency. The blood coagulated very slowly, and the coagulum was not firm; the serum did not separate; and the coagulum had a tremulous jelly-like appearance, the precipitated red globules being discernible through it. The red colouring matter was in less proportion than usual, probably from repeated hemorrhages. There was no trace of a buffy coat. M. Rayer says, that at the commencement of hemorrhagic purpura without fever, he has not detected any thing unnatural in the blood, but after many hemorrhages it became more serous. In febrile purpura I have many times seen a very marked buffy coat upon the blood.

The Archives of Science contain some instances of persons subject to spontaneous, or easily excited hemorrhage. This tendency has often seemed to be hereditary. There is usually in these cases a laxity and weakness of the solids, and an extreme fluidity of the blood, which coagulates but slightly and with difficulty, whence it is almost impossible to arrest the hemorrhage. Dr. Lereboullet (*Thesis sur l'Hérité des Maladies*. Strasbourg, 1834,) has collected the principal facts of this sort related by German authors. M. Lobstein has noticed some in his Treatise on Pathological Anatomy.

LIND in his excellent Treatise on *Scurvy*, translated into French 1756, accounts for the phenomena of this disease by the debility of the solids and the alteration of the fluids, of the blood in particular, which seems to him disposed to putrefy.

According to *Fourcroy*, quoted by Orfila in his *Elements of Chemistry*, (t. ii, p. 313,) the blood drawn from the gums of a scorbutic patient contained no fibrine, remained fluid and became dark on cooling. It yielded instead of coagulum, only some flocculi of gelatinous matter.

M. James, Interne at la Salpêtrière, in an article in the January number 1838, of the *Gazette Medicale*, quotes an analysis of scorbutic blood recently made by M. Fremy, demonstrator of Chemistry at the College of France. This blood was found to be strongly alkaline, a circumstance already remarked by Boerhaave, and contained but little fibrine. M. James himself says he has observed that blood taken by venesection from scorbutic patients was more fluid than common, gave a small, soft, and friable coagulum, and quickly turned litmus paper, which had been reddened by an acid, blue. M. Magendie, has succeeded in producing in animals a true artificial scurvy, by giving to the blood the qualities which

it acquires in ordinary scurvy, either *liquefying* it by injecting a solution of subcarbonate of soda, or *defibrinating* it directly and re-introducing into the vessels the blood at first taken by venesection, and afterwards beat up in a vessel by means of a glass rod. But a mere clinical observation suffices to demonstrate in scurvy a condition of fluidity and *dissolution* of the blood, as Boerhaave expresses it, which satisfactorily accounts for the chief phenomena of scurvy.

SEC. IV.—**TYPHOID FEVER.**—The name of putrid fever, which has so often scandalised reformers in medicine, must not be taken literally. The physicians of former days never contended for the existence in the living body of a corruption or *putrefaction* of the humors like that which takes place after death. Alexander de Tralles, (lib. xii, ch. 11,) had long since remarked that many observers had said that fever did not originate in a putrid state properly so called, frequently repeating, that the humours were heated and dried in the vessels, but that they did not putrefy. Continued putrid fevers (says Van Swieten, Comm. sur les aphor. T. ii in 4°) are those in which the humours have degenerated much from their natural condition and seem to have a tendency to putridity, and as this degeneration is more or less decided, we see different degrees of malignity in the symptoms.

But clinical observation has long ago established the alteration of the blood in diseases which are called *putrid*.

So Fernel (de Febril. cap. v.) remarks, that the blood which is drawn from the veins in putrid fevers, is not merely fetid and disagreeable to the smell, but even putrid; in such a manner that it can neither coagulate nor concrete, its fibrinous parts being as it were dissolved in the process of putrefaction.

Schwenke also affirms, that blood which is taken from subjects attacked by putrid and especially pestilential fevers, appears to be in such a state of *dissolution*, that it cannot coagulate, that it is sometimes found to be gangrenous and putrid. The same alteration of the blood is seen in persons subjected to a long course of diet in whom the blood becomes putrid and *alkaline*. Morton (Pyretolog. part 1) says distinctly, that on bleeding a woman sick with malignant fever, the blood gave out so fetid an odour, that the surgeon and his assistants fainted.

In the pestilence observed during the siege of Breda by Van der Mye (de modis Bredanis,) the blood of infected persons appeared livid, fetid, and *did not coagulate*. Some of the invalids moreover sunk under a frightful epistaxis, in less than four hours.

Wepfer (Cicutae aq. hist. et noxae. cap. v. p. 52,) also has remarked in malignant and petechial fevers, the most dangerous hemorrhages from the nose, uterus, and kidneys. He has moreover seen blood, which had been kept for some time after its abstraction, incapable of coagulating.

Pringle, (Maladies des Armies, 1752,) and Huxham, (Casai sur

les Fièvres, chap. v. *De l'état de dissolution et de putréfaction du sang*) have made similar observations.<sup>1</sup>

These observations have been frequently confirmed by our most distinguished cotemporaries, (it will suffice for us here to cite the names of MM. Andral, Cruveilhier, Bouillaud, Trousseau, Gendrin, &c.) A memoir of M. Raciborski in the February number 1839, of the *Gazette Medicale*, will give us recent facts and calculations in corroboration of our opinion. These facts have been collected at the hospital of La Charité, in the practice of M. Bouillaud.

"We have taken," says M. Raciborski, "accurate notes of the condition of blood drawn in typhoid fever, 111 times by phlebotomy, and sixty-eight times by cupping. Of the 111 bleedings there were forty-six in which the coagula exhibited no buff, or merely some small soft and semitransparent buffy patches. All these coagula were at the same time more or less dark and frothy, and had moreover different degrees of consistency, some being able to support half of their weight, and others dividing with the pressure of the finger necessary to raise them. The serosity which surrounded the coagulum was always small in quantity, and without being turbid, it was never so clear as in bleedings during a recent phlegmasia. Cupping performed thirty-two times upon the same patients furnished soft dark globules, forming a mass similar to ill picked grapes, or a kind of porridge, suspended in a serosity more or less reddened by the colouring matter of the blood, sometimes almost black. All these bleedings, both general and local, were practised upon twenty-one patients and in no instance was a complete buff exhibited.

"Among eleven other patients attacked with simple uncomplicated typhoid fever, the bleedings have furnished some coagula covered with a buff; thus of twenty-seven bleedings, eighteen exhibited a buff, but in nearly all these cases it was slight and semitransparent, and when it was a line or a line and a half thick, it was infiltrated as if œdematosus and easily broke if one attempted to raise the coagulum. It is singular that, notwithstanding the presence of this imperfect buff, which might lead to the belief that an important change had taken place in the condition of the blood, the contents of the cupping glasses always preserved unchanged the characteristics of typhoid fever; they were almost always flabby, ill formed, ragged and porridge-like. Some exhibited a little form and consistency after several emissions of blood, and this condition always coincided with a marked amendment of the general condition of the patients.

"Lastly, we come to the examination of patients in whom, be-

<sup>1</sup> Do we not find in similar cases, the altered blood repugnant to the leeches to be applied to the patient, sometimes even acting upon them as a stupefying poison, so that they swell, or do not suck, or die upon the skin? Examples of this fact have been recorded in several grave epidemics, in *typhus*, the *cholera*, &c.

sides the usual symptoms of typhoid fever, there are indications more or less decided of inflammation of the respiratory organs, throat, brain, &c. Of twelve patients attacked simultaneously with bronchitis and typhoid fever, there were five in whom the blood exhibited no buff, or merely some small soft semitransparent patches, at the same time that the coagula were feeble and torn by the least pressure. In every case the affection of the respiratory organs was slight and usually not extensive. Upon seven other patients twenty-four bleedings were practised, and of these seventeen did and seven did not yield a buff. With the exception of four patients of whom we shall speak immediately, all the bleedings practised upon the three other patients show a grayish, soft, semi-transparent buff, which broke at the least pressure, and could sustain at most one half, very seldom two thirds of the weight of the coagulum. The four patients who constitute the exception must be examined more in detail. One of them had been attacked with a severe general bronchitis; he was bled three times, and the two first bleedings furnished coagula covered by a buff nearly a line and a half thick, and sustaining their weight; in the third the coagulum had no buff and was not firm; but at this time the inflammation of the respiratory organs was much diminished.

"The second patient had at his entrance but slight bronchitis with decided typhoid fever; he was bled at first twice in the two first days, and the two bleedings furnished coagula feeble, having no buff and easily torn. The third day respiration was much embarrassed. On examining the chest pneumonia was recognised. He was again bled three times, and the affected side was twice cupped. The first two bleedings presented a complete buff, sustaining the weight of the coagulum; in the third bleeding the coagulum had no buff, but was glutinous and supported its own weight very well.

"The third patient, who had at first slight bronchitis with the typhoid fever, gave on the first day blood without a coagulum and of moderate consistency; the second day symptoms of pneumonia appeared, and the two subsequent bleedings furnished coagula with a buff as in the last patient.

"Finally the fourth patient having typhoid fever with bronchitis and slight pleurisy, was bled three times. The coagula of the two first had no buff, but were glutinous and of tolerable consistency. The coagulum from the third bleeding was equally glutinous at the same time that it had a slight buff upon the edges.

The blood taken by cupping exhibited nearly the same characteristics (typhoid) in the patients of this last category as in the preceding; thus, although the coagula were covered with a buff, the round masses from the cupping glasses were nevertheless soft, ill-formed, and the serosity of the blood now reddened by the colouring matter; the four patients of whom we have last spoken being excepted from this category. While the coagula presented in these

patients true signs of inflammation, the same characteristics belonged also to the globules of the cupping glasses and their serosity.

"Four of our patients attacked with typhoid fever had at the same time more or less of angina tonsillaris. In three of them the blood was not sensibly modified by the affection of the throat, although in one case it was sufficiently decided. The fourth patient was twice bled, and at each time a coagulum was formed with a slight buff easily torn when raising it. Cupping in this patient gave blood of a tolerable consistency.

"One patient presented with the typhoid fever symptoms of a severe colitis, and at three successive bleedings the coagula were covered with a buff, one of which was sufficiently strong to sustain the weight of the coagulum; the two others were easily broken. The blood from the cups preserved nearly the usual characteristics of typhoid fever.

"Two patients had with the typhoid fever a slight swelling of the testicle. The coagula from them had rather more firmness than is usual in typhoid fever, but no buff.

"Lastly, one patient entered the hospital with symptoms of typhoid fever, in whom the first bleeding yielded a coagulum covered with a delicate, feeble, semi-transparent buff. Another bleeding on the following day gave a somewhat thicker and firmer buff, and on the same day supervened a furious delirium with spasmodic motions of the muscles, in consequence of which we were obliged to have recourse to a straight jacket, and to direct our treatment immediately to the meningitis, which had come on, and to which the buffy condition of the blood was attributable.

"It follows from what we have said, that the blood taken in typhoid fever either by phlebotomy or cupping, presents peculiar characters which are never seen in simple inflammations of a certain degree. The coagula are commonly blackish, without a buff, surrounded by a small quantity of serosity, sometimes a little turbid, sometimes clear, but never so limpid as the serum of pneumonia or articular rheumatism, while at the same time they are soft, more or less easily cut with the fingers or broken by lifting. In those rare cases in which the coagula have a buff upon their surface; this morbid product is but a slight veil through which a careful observer will always discern the true characters of typhoid fever. In short, this crust, which nevertheless we consider inflammatory, is slight, semi-transparent, and easily torn, together with the coagulum, which has the same characteristics which we have already observed in the coagula without a buff.

"These characteristics are not sensibly changed except by severe inflammations. Thus whenever in distinct typhoid fever we find a firm thick buff sustaining the weight of the coagulum, which is flabby, and surrounded by a serosity proportionally abundant and clear, we may conclude that the patient is attacked with a local

inflammation, and this will be usually a pneumonia or an acute bronchitis."<sup>1</sup>

While inflammations modify the state of the blood taken in typhoid fever by the lancet, they also affect the globules of the cupping glasses, rendering them glutinous, more firm, and better formed. Yet if the inflammation is slight and not very extensive, the blood from the venesection only will be slightly modified, at least in appearance, by the presence of a buffy coat upon its surface; but the blood taken by cups will always bear the indications of typhoid fever, the globules will be then as when the affection is simple, soft, like porridge, floating in a serosity reddened by the colouring matter of the blood, and easily precipitated by shaking the vessel.

If we reconsider the characteristics of the blood in the diseases which have been hitherto the subjects of our inquiry, we shall perceive two general facts, which will serve to divide them into two distinct groups. The diseases of the first class are remarkable for the increased power of attraction between the particles of the blood, and it is to this that the firmness of the globules in the cups and their uniting in one red glutinous mass in pneumonia, articular rheumatism, &c. are owing. Upon this power also, depend the greater or less cupping of the coagula their firmness and glutinous aspect or thick buffy coat, strong and sustaining the weight of the coagulum, and lastly the perfectly limpid state of the serum of the blood in the same diseases.

The diseases of the second class, on the contrary, are distinguished by a diminished power of cohesion among the molecules of the blood. Thus we shall see no well cupped coagula; a great part of the fibrinous globules will remain in solution in the serum and prevent it from becoming so clear and limpid as in the former group, its quantity will be always less for it, for it depends upon the power of attraction with which the molecules of blood approximate to each other and force out the serosity contained among them; lastly we shall not see in this group the thick buffy coats which will support the weight of the coagula.

A question which it would be very desirable to settle is, whether the lesion of the blood which we have demonstrated in typhoid fever, is primary, or secondary. Each of these opinions has its supporters. It must be confessed that the examination of the blood

<sup>1</sup> There is a great difference between the consistence of the clot subjacent to the buffy coat in a pleuro-pneumonia and that of typhoid fever; in the former case, the blood is extremely flabby, and forms scarcely a sort of jelly; for the greater portion of the fibrine, upon which its consistence depends, ascends to the surface to constitute the buffy coat; in the typhoid fever, on the contrary, the fibrine is equally diffused, and the softness of the clot is owing to its slight degree of density occasioned by the diminution of the force of attraction between the molecules of the fibrine: it is not less in quantity, and for this reason whatever be the softness of the clot in typhoid fevers, it is generally more firm than in the intense pleuro-pneumonies where it is buffy.

would tend very much to settle 'with many physicians this as yet doubtful question; but for this more favourable circumstances would be necessary than those under which we collected our observations. Unfortunately the nature of the disease is such that the patient at its access considers himself as labouring under a temporary indisposition, and does not at first seek medical aid. This is especially true of those who seek relief at hospitals and do not usually apply for it until they are unable to pursue their common occupations. It is very desirable that physicians attached to large public institutions, such as colleges, asylums, &c. should undertake the solution of this question.

We cannot but observe in concluding this subject, the singular correspondence which exists between the different states of the blood that have been described and the condition of the muscles. The weakening of the muscular contractility is a prominent symptom in typhoid fever, the strongest are prostrated; the legs bend beneath the body, and refuse their support. If we ask a patient how he reached the hospital, we shall almost always find, that he came in a carriage, or litter, or in the arms of his parents or friends. This symptom is not commonly found in those affections in which an increased power of attraction is found between the molecules of the blood. We very rarely see patients with pneumonia or pleurisy obliged to lay upon a bed at the commencement, and they sometimes walk to the hospital complaining of no fatigue. May not the muscular fibre of which the blood is in one sense but a solution, (*Chair Coulante de Bordeu*) participate in typhoid fever in the looseness of the particles, which we have already remarked in the blood of these patients. This suggestion, which I consider capable of being further developed by the mind of some philosophic observer, may be supported by several observations, and among others by one for which we are indebted to Duhamel. In this observation an ox, which was killed after being foundered, exhibited a peculiar lesion of the blood. A few drops of this fluid falling upon the hands and face of two females caused a gangrenous inflammation of these parts, and the butcher who took in his mouth for a few minutes the knife which he had used, presented a few hours after a swelling of the tongue with blackish pustules over the whole body, and in a few days died.

In this instance the exhaustion of the muscular contractility seems to have greatly influenced the condition of the blood; in typhoid fevers on the contrary, the muscular contractility seems to be impaired in consequence of a previous lesion of this fluid: but in these two cases we merely see a twofold mode of connection of morbid phenomena, as in practice we frequently observe phenomena which from being local becomes general, and *vice versa*.

If these relations which we have supposed between the condition of the blood and the muscular fibre really exist, we may in the same manner account for the softening of internal organs which is often met with in typhoid fever.

On the other hand, the firmness of the external muscles, of the parieties of the heart, of the liver, of the spleen, &c. which is common to persons who die of pleuro-pneumonia, or acute articular rheumatism, would corroborate our idea ; in the one case the blood being at fault in hastening, as it were, the normal period of assimilation, while in the other, this natural tendency of the blood is impaired and its assimilation prevented.

We find indeed in the same journal (*Gazette Médicale*, 30 November, 1837,) a paper by M. Forget, which seems to be intended as a counterpart of the above. Giving to the author great credit for his historical and critical examination, and for his clinical and arithmetical researches, we cannot but protest against the views on which they are based. Let us rid ourselves of this skeptical and weak system, which is satisfied to destroy without providing any substitute, and which seems to triumph in its haughty impotence, while it arrives at no conclusions.

The smallness and want of consistency of the coagula of the blood in typhoid fever are (says M. Lecanu, *thèse*, 1837,) almost certain indications of a proportional diminution of its globules. The chemical analysis of the blood of two persons having this disorder, one twenty-three, the other twenty-six years of age, confirmed this prediction, and gave the following results.

	First patient.		Second patient	
Water,	805.2	Water,	795.88	
Globules,	115.0	.	105.0	
Albumen, extractive matter, saline and fatty,	79.8	.	99.12	
	<hr/> 1000.0		<hr/> 1000.0	

Consequently, (see commencement of this dissertation) in the first patient the proportion of globules was less than the mean, and in the second much less than the minimum of the blood of persons in health.

Vauquelin, in vol. xvi. of *Annales de Chimie*, has proved the existence of hydro-sulphate of ammonia in putrefied blood. Many authors in consequence of the odour, colour, and rapid putrefaction of the blood, have admitted a kind of decomposition of this fluid in putrid fevers ; it would be interesting to discover if this salt can be formed during life, in persons labouring under this affection, or produced at the moment of the examination.

M. Bonnet, of Lyons, in a very excellent surgical essay, (*Gazette Médicale*, 23d September, 1837,) has engaged in this research. We will quote from the author.

" If we have not been able to prevent the decomposition of pus, and the consequent absorption of noxious particles, can the demonstration of their existence lead to any practical benefit ? I believe not. We may stimulate the secretion of urine in order to free the system of the hydro-sulphate of ammonia, seek to neutralise the

excess of ammonia in the blood by acids, to decompose the sulphurated hydrogen by the chlorurets, or to neutralise it by the salts of lead which would form an insoluble sulphate, but it would be folly to attribute to these means any real efficacy. According to the laws of chemistry, neither of these articles would decompose or neutralise completely the hydro-sulphate of ammonia while it is dissolved in the serosity, and even if this decomposition and neutralisation should take place, it is by no means certain that the blood would be restored to its normal condition. The following experiments may throw some light upon the subject.

At one time, when I supposed that in diseases called putrid the blood contained hydro-sulphate of ammonia, without having been able as yet to demonstrate it, I thought, that if the blood found at the autopsy of persons dead of typhoid fevers, or purulent absorption, owed its permanent dark hue, its fluidity, and freedom from coagula, to its mixture with hydro-sulphate of ammonia, I might impart the same characteristics to healthy blood, if I mixed it while flowing from the vein with hydro-sulphate of ammonia: and in order to verify this idea, I caused blood taken from persons slightly indisposed, to be received partly in clean basins and partly in vessels containing hydro-sulphate of ammonia, or solutions of sulphurated hydrogen. The blood mingled with either of these solutions, the proportions of which were one fifth or one fourth part in volume, coming from the vein black, preserved the same colour however long it was exposed to the air, and continued fluid, while the blood of the same persons taken in clean vessels, became red and separated into serum and coagulum. Since the blood mixed with hydro-sulphate of ammonia had all the sensible qualities of that found in persons dead of typhoid fevers, and purulent absorptions, I pursued the experiment by adding to it acetic acid, subcarbonate of lead, chloruret of chalk, &c. but it neither recovered the power of reddening itself, nor did it separate into serum and coagulum, a result which renders probable, if it does not demonstrate it, that the lesion of the blood is too serious to be restored by the introduction of substances which decompose or neutralise in part the hydro-sulphate of ammonia, and that therefore in the treatment of diseases which may furnish the elements of putrefaction, our attention can be usefully directed only to preventing the developement of these elements.

" From the time that I discovered in the blood and urine of the patient whose case I have related, hydro-sulphate of ammonia, I have intended to seek it by the same methods in these fluids, among persons labouring under severe typhoid fevers and purulent absorptions, the sequelæ of operations, or of the opening of large abscesses.

" But at present I have not met with favourable opportunities for prosecuting my researches. I should wish to meet with typhoid fevers at the epoch when intestinal ulcerations produce a fetid suppuration, and for cases of purulent absorption marked by the access

of fever preceded by chills, and followed by profuse sweats. But although these grave affections have not for some time come under my observation, they are sufficiently frequent to enable others by the method I have described, to determine the quantity of hydro-sulphate of ammonia in the blood, urine, and sweat of those affected with these diseases, and, in general, of all persons exhibiting the symptoms formerly denominated putrid.

"Since it is always easy to examine the urine, and as from what has been above quoted, if the blood contains hydro-sulphate of ammonia, the urine does also, it is best to begin with the examination of the latter. See if it has lost its acidity and become alkaline; in which case use re-agents by which the ammonia may be liberated, after which, ascertain if the vapour arising from the same urine heated contains sulphuretted hydrogen.

If this vapour occasions no change in papers dipped in solutions of lead, arsenic, &c., add sulphuric acid in order to disengage the sulphuretted hydrogen. I have examined in this manner the urine of many persons having a fetid, ammoniacal suppuration without any signs of absorption, but without detecting either sulphuretted hydrogen, or ammonia. If I had succeeded in finding these materials in the urine, I should have extended my researches to the blood and the perspiration; to the perspiration under the armpit and upon the chest by papers of turmeric, litmus, subacetate of lead, &c.; and to the blood by examining its vapour according to the method already detailed.

"It is my hope that these means of investigation, which require but few re-agents, and a very simple apparatus, may be applied to severe cases of fever, and purulent absorption by numerous persons, who are convinced of the necessity of ascertaining the changes of the fluids in these diseases, and substituting the precision of science for the vagaries of humoral hypothesis. If I should stimulate others to these labours, and if my methods of investigation should be applied by the hands of others, I shall have attained the object of this work.

"Some persons have experimented upon the electrical condition of the venous blood. According to Rossi, the electrical condition of the blood in severe febrile affections differs from that of health, and according to Bellingeri, the appreciable quantity of electricity in the venous blood is lessened in old age, and in certain diseases." (See Theses of the faculty of Paris; *Saucerotte*, August, 1828; and *Coudret*, Researches on animal electricity, 1837. See also the experiments of Bellingeri; *Annali univ. di medici. Aprile*, 1827. *Milano.*)

SEC. V.—FEBRILE DISEASES FROM INFECTION.—(Pestilential diseases, and infection or poisoning of the blood, Glanders, Phlebitis, Eruptive fevers, &c.) The observations of Diemerbroeck upon the plague of Nimeguen, (*de Peste libri quatuor*, Arnheim, 1646); the experience of Professor Deidier, of Montpellier, in the pestilence at Marseilles (1722); the observations and experiments

of *Morand* and *Duhamel* on over-driven animals;<sup>1</sup> the experiments made, 1822, by *M. Gaspard* upon putrid injections into the veins of animals; the observations and experiments of *M. Leuret* upon the malignant pustule of horses, (Thesis on alterations of the blood, Paris, May 12th, 1826;) the experiment of *MM. Trousseau* and *Dupuy*, preserved in the *Archives de Médecine*, vol. xi. 1826; and many observations of *M. Andral*, (see the article *Blood*, in the *Dictionnaire de Médecine*, vol. xv; *Traité d'anatomie pathologique*; *Clinique Médicale*, &c.) have abundantly proved; first, that the blood and humours are altered in putrid pestilential and carbuncular diseases; second, that we can produce in animals artificial diseases of the same nature by the immediate effect upon the blood of inoculations, or injections of putrid or contagious matters.

Notwithstanding these experiments are so recent and well known, I cannot refrain from introducing here a few of *M. Deidier*, and one of *M. Leuret*.<sup>2</sup>

<sup>1</sup> *Duhamel* relates, that the blood of an over-driven ox produced, by simple contact, in four individuals gangrenous affections, two of which were mortal. We must also cite the observations of *Esnaux* and *Chaussier* upon the *malignant pustule*, &c. &c.

<sup>2</sup> "The introduction of a certain number of deleterious substances into the blood, such as pus, putrefied substances, poisons from one of the three kingdoms, has the undoubted effect of producing in the blood various alterations, whence result its incoagulability, and rapid tendency to decomposition. When these alterations of the blood have been thus produced, the following phenomena may often be observed: first, the nervous centres are affected, and in proportion to the degree or nature of this affection, arise, either instantaneous death, more or less considerable prostration, convulsions, delirium, &c., or neuroses of organic life, as dyspnœa, palpitations, vomitings; second, gangrene of one or more parts; third, a great number of serous or sanguineous exhalations; fourth, unusual gaseous secretions; fifth, more or less general disorder in the functions of the different organs.

In opening the bodies of animals, in whom these different morbid phenomena have existed, sometimes we do not find any appreciable lesion, sometimes there are congestions, effusions of blood similar to those observed during life; at others, the existence of alterations more or less profound is met with in the texture of the different solids. Among these variable phenomena, we find as constant, first, a remarkable fluidity of the blood; second, a more rapid decomposition, both of the blood itself, and the solids penetrated by it. What is the point of departure for these different phenomena? is it not manifestly the blood, into which deleterious substances have been introduced? Now these disorders of the functions and organs, produced by the immediate introduction into the blood of various deleterious substances, are exactly the same with those produced by the bite of certain animals; they also arise from contact with the flesh of animals, who have perished with anthrax; the same are observed in the variola, rubeola, malignant scarlatina. These same disorders are manifested in individuals exposed to putrid emanations, vegetable or animal, to the miasma arising from the bodies of other sick persons confined in close places, in which the air is constantly infected without being renewed. Finally, these same disorders appear in those individuals, whose blood is but imperfectly or viciously repaired by an insufficient or unhealthy diet."—(Andral, *Précis d'Anatomie Pathologique*, t. i. *Alterations of the blood*.)

*M. Gaspard* has performed a certain number of experiments upon dogs.

"A dog of the hospital of Mail, at Marseilles, accompanied the surgeons during the dressing of the patients, eating all the carious glands, and licking up the blood spilt upon the ground of the infirmary, and during three months that he continued this practice enjoyed perfect health. We injected into his crural vein on the right thigh, a drachm of pestiferous bile, diluted with two ounces of tepid water, and he perished on the fourth day, like the others having a bubo upon the wounded thigh, to which supervened two carbuncles, while the wound became gangrenous.

"We collected the bile of one of the dogs dead of the distemper and injected it into the crural vein of another. Immediately upon the injection occurred universal convulsive motions, followed by a lethargic stupor. The next day a carbuncle appeared upon the great pectoral muscle on the right side; on the third day a considerable bubo appeared upon the thigh, and in the course of the day the animal died. On opening the dog, we found the front of the chest completely gangrenous under the integuments and in the interior, the viscera engorged with thick, black blood as in the others."

For the sake of comparison, and to give the above experiments a greater degree of certainty, Deidier also injected the veins of several dogs with bile taken from the bodies of men, who had died of diseases which were not pestilential, and these dogs were for the most part hardly affected at all, and speedily recovered.

The following is the experiment of M. Leuret. The right jugular vein of a horse attacked with malignant pustule, and the left jugular vein of a sound mare, were opened and isolated for the

(Consult the t. ii. of the *Journal de Physiologie*, 1822.) He injected pus into the veins, death was never instantaneous; the animal usually recovered, when the quantity of liquid injected was not too great (several ounces), or the injection repeated.

He cites from H. Kerckringius, the case of an infant with an abscess in the neck, and which died of marasmus. At the autopsy the walls of the jugular vein were found to have been corroded, so that the abscess had gradually emptied itself into the cavity of the vessel; a considerable quantity of pus was found in the right cavities of the heart. From this, he is led to consider the hectic fever of the phthisical as caused by a quantity of pus introduced into the circulation by absorption, venous or lymphatic. According to Magendie, it is always the result of venous, and never of lymphatic absorption. Notwithstanding Portal and Dupuytren have seen pus in the lymphatic vessels and thoracic canal.

In another series of experiments the same gentleman introduces into the economy, water containing animal matter in a state of putrefaction; death was the constant result: the lungs were engorged, hepatised, ecchymosed, stools bloody, melæna, no clots in the vessels.

The putridity of vegetable matter acts in the same manner as azotised substances, but with less intensity. Whence he concludes, that the scurvy and all putrid diseases are produced by a putrid principle introduced into the torrent of the circulation, by the air, or by the diet: he also declaims against the use of venisoned meat, stinking game, infected cheese, &c. and other substances from this cause esteemed delicacies, already proscribed by Seneca. (*Epist. 93.*)

length of several inches. A double communication was established between these vessels by means of two tubes, so that the blood coming from the head of the one entered the heart of the other, and vice versa. The transfusion lasted about seven minutes, after which the animals were separated. The diseased horse died the next day, and exhibited all the alterations peculiar to this malady. The mare was nowise affected for the few first days, but soon became languid, and acquired a yellowish tinge of the conjunctiva, with a disordered state of the lids; respiration became difficult, the pulse at first excited was frequent and hard; the skin hot, the tongue dry, and a viscid saliva flowing from the mouth. These symptoms rapidly increased, and death took place in seven days after the operation. On opening the body, numerous ecchymoses were found in the left ventricle of the heart, in the lungs and the intestinal tube. The uterus, which contained a foetus of five months was very thick and infiltrated with a yellowish serosity, fetid and like what is usually found around a malignant pustule.

*Dr. Gendrin*, in his *Treatise on fevers and history of inflammations*, has reported many curious facts and experiments with reference to the infection of the blood in severe diseases, some of which will be found in the article *sang* of the dictionary above cited.

Yellow fever also is a disease in which the blood undergoes an evident alteration, (see works published by MM. Bally, Troussseau, Louis, &c.) The blood is equally infected in the disease properly denominated *typhus* fever by modern authors.

*Glanders*, which has recently been recognised in man, thanks to the indefatigable perseverance of M. Rayer, must undoubtedly be classed among those virulent and contagious affections, whose primary cause is an infection of the blood. In all the attempts at inoculation which have been as yet made, one of which, a recent and successful one, was communicated to the Academy of Medicine at one of its last sittings, by M. Leblanc, veterinary physician, the disease has proved to be communicable not by the blood, but solely by the product of the purulent secretions in which the virus seems to be contained. We would refer, for further information upon this subject, to the excellent memoir of M. Rayer, preserved in the archives of the academy for 1837.

All contagious diseases, *eruptive fevers*,<sup>1</sup> *hydrocephalus*,<sup>2</sup> *syphilis*,

<sup>1</sup> Some chemical analyses establish, that the blood in the eruptive fevers undergoes modifications analogous to those which we shall afterwards point out as accompanying plethora, and inflammatory disorders: that is, it is increased in density; the aqueous medium is diminished in proportion to the increase of the clot; consequently, the proportion of the globules is increased. Two analyses by M. Lecanu, of the blood of two young persons, bled on the first attack of *scarlatina*, gave the following results:

	No. 1.	No. 2.
Water,	776.55	770.41
Globules,	144.55	146.80
Albumen, &c.	78.90	82.79
	1000.	1000.

&c. show, from the manner in which they are communicated from one individual to another, from the mode of their development, their symptoms, progress, and termination; striking indications of an infection of the blood, but as yet this infection is proved only by analogy; at least I know of no fact, which demonstrates this alteration of the blood, if we except the experiments and observations quoted in the preceding notes.

The bites of venomous animals, and especially of the *viper*, occasion an alteration more or less decided in the blood, (see report of *M. Fouquier* upon the experiments of *Mangili*, vol. xxxi of the *Bibliothèque Médicale*, 1811.)

Cases of poisoning, and especially those by arsenic, which has been of late the subject of much curious and beautiful investigation,

In the grave confluent *variola*, on the contrary, the blood appears to undergo an alteration analogous to that presented in the malignant fevers. *M. Gendrin* (*Hist. des Inflammations*, t. ii.) injected into the veins of animals blood taken from individuals labouring under confluent *variola*, and thus developed accidents similar to those produced by the injection of putrid matter into the veins.

Is not the miasm and special virus, which is the original source of the eruptive fevers, susceptible of being transmitted by inoculation with the blood? The rubeola has thus been successfully inoculated, if we may trust the experiments of *F. Home*, copied at the time into a French journal of medicine, and also cited in the work of *M. Rayer* upon diseases of the skin.

*Inoculation for Rubeola*.—*Dr. Home*, of Edinburgh, was the first to experiment upon the inoculation of rubeola; but as this eruption does not form matter, and as it is difficult to collect the particles of skin (the cuticle,) which separate upon desquamation, he made use of the blood drawn from the more superficial veins in places where the eruption was most developed. The blood, which issued from a slight incision, was collected upon cotton, and this moist cotton was applied with some degree of pressure to incisions in the arm of the individual to be inoculated. The precaution was taken to allow the wound to bleed before the moist cotton was applied, in order that the blood might not diminish the effect of the virus, and it was left on the wound for three days.

Ten or twelve individuals were thus successfully inoculated; the eruptive fever followed six days after the eruption; the symptoms were milder than in ordinary rubeola, the fever less, the cough slight or completely wanting, the inflammation of the eyes was also very slight, many tears and much mucus were passed by the nose as in ordinary rubeola; the chest was entirely free, a peculiar characteristic of the inoculated rubeola.

*Dr. Home* supposed that the rubeola was introduced by the lungs; to prove this, he allowed a bit of cotton to remain some time in the nostril of an infant with rubeola, and then removed it to the nostril of a healthy infant, that the respiration might introduce the contagion; but the experiment failed.—*FRIEDLANDER*, D. M. P.—(*Bibliothèque Médicale*, t. xxiv. 1809.)

<sup>2</sup> *M. Breschet*, in his experiments upon hydrophobia, produced the infection of the blood and traces of phlebitis by injection of the saliva of a mad dog into the veins.—(*Dikt. des Scienc. Med.*)

*M. Magendie* admits that there exists in hydrophobia a want of coagulability of the blood; according to him, we find in those thus afflicted the same condition of the lungs and other organs, as in animals whose blood has been rendered incoagulable by the injection of a solution of subcarbonate of soda into the veins.—(*Magendie's Lectures*.)

frequently occasion symptoms depending upon a poisoning of the blood.<sup>1</sup>

The asphyxiæ are potent causes of alterations of the blood, either by suspending its circulation and preventing its revivification by the atmospheric air, or else by a direct influence upon it, as in the case of the fumes of charcoal, carbonic acid gas, the miasm of privies, sulphuretted hydrogen, &c.<sup>2</sup> Since, however, it is impossible for us fully to discuss such questions, which are only incidental to our subject, we would refer the reader to *Traité de Médecine Légale*, to the work published, 1836, by MM. Pierry, L'heritier, Fossone, &c. (vol. *Maladies du Sang*,) and especially to the beautiful experiments of Bichat, (*Recherches physiologiques sur la vie et la mort*.)

According to M. Roche, (Journal Hebdomadaire, September, 1833,) the immediate cause of intermittent fevers (of marshy regions) is an infection of the blood by the miasm arising from the marshes, but the arguments by which he supports his opinions are not very philosophical. As this is not a kind of alteration capable of actual demonstration, we proceed. We have mentioned above (Sec. II. *White Cachexy*,) the sort of *hydroæmia* to which, as a secondary affection, persons living in places where fever is endemic are subject.

We have also in this paragraph treated of scrofula, as connected with a lesion of the hematic system. We now merely mention *syphilis*, because the infection of the blood can only be deduced by a course of reasoning (otherwise very logical and correct) drawn from clinical observation. We ought also undoubtedly to mention *cancer*, which is certainly allied to a general diathesis, in most cases primitive and antecedent to the appearance of the local disease; but in some consecutive, constituting the *cancerous cachexy*.

<sup>1</sup> The following experiments are narrated in the Toxicology of M. Orfila: Eight minutes after the injection of three fourths of a grain of the nitrate of silver, a jet of black and venous blood issued from an opening in the femoral artery. Black blood was found in the left ventricle after the injection of six grains of the hydrochlorate of tin, or of the nitrate of bismuth; it is fluid, and of a deep red after poisoning by the liver of sulphur; it is thick, viscous, black, after poisoning by the sulphuretted hydrogen. M. Jager asserts that the abdominal venous system is constantly gorged with a grumous blood after the ingestion of arsenious acid. Magendie and Delille found the blood more liquid after the absorption of the upas ticuté, &c.—(*Thesis of M. Saucerotte*.)

<sup>2</sup> M. Magendie occasioned *asphyxia* in animals by increasing the viscosity of the blood by the injection of a solution of gum, so as to occasion the stagnation of the blood and obstruction of the vessels; he also produced the same result by the injection of olive oil. In the latter case the arterial blood was black.

M. Rayer, (*Maladies des Reins*, t. i. p. 169,) relates the singular case of a man asphyxiated by burning charcoal, after drinking punch. Yellowish oily globules floated on the surface of the blood and urine. M. Laugier thought there was a separation of the stearine and oleine, and that the floating globules were composed of the latter.

of *Bayle* and *Cayol*. In the latter case, the blood is infected by the resorption of cancerous matter, as is admitted by observers, and especially by M. Velpeau, (*Revue Médicale*, 1827, vol. ii. p. 236,) who thinks that he has demonstrated, by facts, the following propositions:

"A single medullary, or scirrrous mass suffices to infect the whole system, while interstitial absorption is constantly bringing back into the system a portion of the elements of this accidental production.

"These materials may circulate in the system with the recreating fluid, change more or less speedily the constitution of the person, and dispose it to the production of similar tumours, destined in their turn to give rise to others.

"The development of these secondary tumours may take place in two ways. Some particles of this heterogeneous matter being deposited in an organ, serve as an exciting nucleus to promote the secretion at the same point of a greater quantity of the same matter. Or else, which is of less frequent occurrence, some spontaneous, or accidental irritation of a wholly different nature, becomes speedily modified by these fluids in their altered state.

Every thing which has been said of cancerous tissues, (says the same author) is applicable to tubercles, especially where they are softened or purulent, so that all inflammations which appear in a person labouring under phthisis, differ essentially from similar inflammations in other subjects.

Lastly we come to *phlebitis*, with regard to which we cannot avoid entering into some details. Notwithstanding the accurate observations of J. Hunter upon phlebitis, following venesection; the isolated facts of Morgagni, Frank, Bichat; the mention of inflammation of the uterine, iliac, and femoral veins in puerperal females, (Schwilgué, Clarke, and Wilson;) the accurate and minute observations of Fizeau (1812, *Biblioth. Médicale*, vol. 38. Suppuration in the hepatic veins following remittent bilious fever with jaundice;) of Ribes, (1816,) of Breschet (1820,) of Velpeau (1824, *Phlegmatia alba dolens*; 1825, Cancer; 1826 and 1827, Pus in the veins;) of Cruveilhier, (1826 Phlebitic capillaire;) this disease was not recognised in nosological tables, until in 1828 Dance did so, and his labours have been prosecuted and extended by numerous observers. These labours gave rise to a renewal of the humoral pathology which is now progressing and upon which it has fallen to my lot to speak at this concourse.

According to M. Cruveilhier, (Dictionnaire de Médecine in 15 vols., vol. xii. Paris, 1834,) "phlebitis presides as it were over all pathology; it is the link which connects the blind, instinctive humoralism of the ancients with the rational humoralism of the moderns, it has restored by rendering intelligible the words *alterations of the blood*, *infection of the blood*, which the school of Pinel had consigned to ridicule, and by subjecting them to positive experiment has explained a host of phenomena which had defied all explanation and all theory."

According to the same author, *suppurative phlebitis* (the only one which will be mentioned here) is developed under those local and individual circumstances which favour the production of hospital gangrene and typhus. Its general phenomena are those of severe fevers commonly attributed to purulent absorption, an opinion which is denied by M. Cruveilheir, who adopts that given in the last century by *Quesnay*, who says; "There have sometimes been found in persons, who died eight or ten days, or even later, after the first indications of absorption, local inflammations and abscesses, together, occasionally in the lungs, more frequently in the liver, and sometimes in the brain; whence it would seem, that abscesses formed subsequent to an absorption of pus, are not a mere aggregation of the absorbed matters, but are almost always the result of an inflammation excited by the matter. These abscesses must also be the cause of the suppression of the suppuration and its accompanying accidents. The cause has been mistaken for the effect in attributing them to a reflux of the pus."

In support of this opinion, M. Cruveilheir quotes his own experiments, and the memoir on capillary phlebitis in vol. iv. 1826 of the *Nouvelle Bibliotheque Médicale*, having this title; *Researches on the actual seat of inflammation*. These experiments fully establish the following proposition.

"Every foreign substance carried unchanged into the venous system produces, when its elimination by the emunctories is impossible, visceral abscesses similar to those which follow wounds and surgical operations, and these abscesses are the result of capillary phlebitis of these same viscera."

The lungs provide an exit for foreign substances introduced into the general circulation, and the liver for those introduced into the abdominal venous system, while under certain circumstances, they serve as a barrier to prevent their escape. All the morbid agents, which with the food enter the intestinal canal, reach the liver which retains them, or evacuates them by means of a copious bilious secretion or else allows them to pass through the channels of the general venous circulation. Those morbid agents which enter the system otherwise than by the alimentary canal having traversed the liver, arrive at the lungs, to be retained, or evacuated by means of the abundant exhalation peculiar to this organ, or else to be transferred to the pulmonary veins, and thence to the arterial current which distributes them to all the organs, and deposits them in the general capillary system.

The eliminating power of the system, so active when endeavouring to rid itself of noxious materials which have entered by means of absorption, most frequently fails, when these materials are introduced directly into the circulation, or originate there as in phlebitis.

The pus circulating with the blood is arrested in different parts of the capillary system, causing capillary phlebitis, and circumscribed inflammations, which sooner or later result in abscesses.

Pus is arrested in the lungs most frequently, sometimes in the liver and rarely in the spleen, or it may traverse several times in succession the capillary system, and produce circumscribed inflammations in various parts of the body.

There are but three modes in which pus can be naturally introduced into the current of circulation. 1. Direct injection into the veins or arteries; 2. the attraction exerted by a gaping vein; 3. phlebitis.

Pus having mingled with the blood is no longer pus, but an irritating substance. Nevertheless, much attention has of late been devoted to the process of the formation of pus and the demonstration of its existence in altered blood.

M. Donné published in 1836, in vol. xi. of the *Archives de Médecine*, (2d series) a memoir on *The Distinctive Characters of Pus*, and the means of demonstrating the existence of this liquid in the different fluids with which he found it mingled, especially the blood. He brings forward, considering it as merely hypothetical, the opinion of M. Piorry, who thinks, that *inflammation of the blood* may occasion a formation of pus in the blood, and also the opinion of the same author as to the existence of a pyohæmic enterorrhea, the cause of which is a mixing of pus with the blood. He is surprised at the assertion of M. Gendrin, who says, vol. i. p. 25, of his *Histoire Anatomique des Inflammations*, that he has found pus in the veins after having injected this fluid into the serous cavities and cellular tissue of dogs. He denies the character attributed by M. Piorry to granular concretions which form on the coagulum of the blood, and according to this observer, indicate the presence of pus in the blood. But he inclines to the opinion of M. Gendrin, (considering it merely conjectural,) who admits, that the globules of pus are only globules of blood, which have undergone a sort of transformation. (M. Donné has since entirely relinquished this opinion.) Finally he endeavours, by using ammonia, which dissolves the globules of blood without acting on the pus, to distinguish by the microscope the blood altered by the presence of pus from the normal blood. M. Donné did not at first propose this means very confidently, and has now abandoned it as very imperfect, having substituted for it the following method, which is applicable only to blood at the moment it is taken and in considerable quantity. The blood is defibrinated and then left quiet in a basin. The fluid separates itself into three layers, the serum above, the red globules at the bottom, and on their surface a coating of pus. If this coating is sufficient in quantity, it is skimmed off and mixed with concentrated ammonia, which converts it into a stringy, glairy substance, easily recognised.

In the treatise which has been quoted, M. Donné also suggested as merely probable, the following peculiarities: blood altered by the presence of pus remains fluid, and presents a singular violet hue.<sup>1</sup>

<sup>1</sup> M. Velpeau (*Memoir upon the Alteration of the Blood*, t. ii. 1827, of the

Dr. *Louis Mandl* (Records of the Academy of Sciences, February, 21, and September, 1837,) quickly refuted the opinions above quoted, and even succeeded in bringing over M. Donné to his own. In his *Anatomie Microscopique*, (2d part, 1839,) M. Mandl remarks anew upon the insufficiency of the means proposed for ascertaining by means of the microscope the presence of globules of pus among the globules of blood, and proves the existence of white globules in the blood of the mammifera. These white globules originate, according to him, in the fibrine which coagulates on the object glass. They do not exist while the blood is circulating, and form after the blood has been received upon the object glass, or in the vessels after death. *Microscopic examination cannot determine whether the blood is pure or mixed with pus*, since the purest blood contains globules in every respect like those of pus, mucus, saliva, urine, effusions, &c., and these last are simply globules of coagulated fibrine. The globules of pus have a mamelonated form; their size varying from 1.110 to 1.80 of a millimetre. This measurement must of itself decide the question as to purulent absorption, since globules of this size never could pass through the walls of the vessels. They partake of the chemical characters of fibrine; they dissolve slowly in hydro-chloric acid at the ordinary temperature; acetic acid contracts them; ammonia and potash dissolve them by degrees; water enlarges them, &c.

The same author opposes the opinion of M. Gendrin, as to the transformation of blood into pus. "We have," says M. Mandl, "mixed blood with pus, but in order to study more easily and exactly the changes in the globules of blood, we have first separated the fibrine by agitating the blood, a process which does not alter the form of the globules of blood. Examining this mixture microscopically, at different intervals, we shall see among the globules of pus, the globules of blood passing through the following changes. The globule is infiltrated, becomes less transparent, and the nucleus is hardly visible; in consequence of which, while lying one over the other, their contour is not clearly distinguishable. Gradually the nuclei become invisible, the globules swell and begin to be fringed, in some of the more transparent globules the nucleus is seen to be out of the centre, and corresponding folds may be seen at the place whence the nucleus has escaped. The globules acquire a great

Revue Médicale,) is of the same opinion. In a man, aged 63 years, who died with symptoms of cerebral congestion, after having experienced various chronic abdominal accidents, the autopsy displayed considerable tumefaction of the liver and spleen. All the blood contained in the heart, aorta, *venæ cavæ*, *venæ mesentericæ*, in fine wherever the size of the vessel permitted an examination, was thick as pap, and exactly resembled the lees of red wine, both in colour and consistence. It was nowhere perfectly fluid, *no where was it coagulated*, and the question might have been asked if it were not healthy pus, mixed with black colouring matter rather than blood. Lastly, it exactly resembled in every respect the red, or blackish brown putrefaction, into which the softened spleen of certain subjects is so readily converted.

degree of elasticity; when pressed against each other elongate themselves in the form of pears, &c.; there supervenes a partial solution of the envelope and the nuclei, which separate into shreds and swim among the globules of pus which are more or less unharmed. All these changes pertain to the solution of globules of blood, they are seen wherever it takes place, and are by no means an evidence of purulent transformation. We may therefore conclude, that globules of pus are not globules of altered blood.

This would perhaps be the place to exculpate the ancient humoralism from the anathema issued against it by Professor Cruveilheir. Like ours, the humoralism of the ancients had its facts derived from observation, and its theories more or less hypothetical.

I have already had occasion to say it (*Lecture upon Changes in the Urine in Diseases, in the Gazette Médicale, Jan. 11, 1840*); The old doctrine of Coction, for example, was founded on the observation of physical phenomena, to wit, the peculiar temperature of the body, and the humoral alterations, which are observed in the course of diseases, alterations which correspond with the different phases exhibited by acute diseases. The ancients could not indeed apply physics and chemistry to pathology, but these auxiliary sciences with which the mere physician is (with very rare exceptions) of necessity but partially acquainted, require to be applied with great caution and reserve. How often have they led astray those who are too hasty in drawing conclusions from experiments which are still very questionable.

Nevertheless, we have given a short exposition of the ingenious theory of M. Cruveilheir upon *purulent absorption*, because it seems to us the most rational.

In conclusion, we doubt the actual presence of pus in the circulation of the blood, and by our methods of analysis cannot demonstrate it.<sup>1</sup>

As to the presence of pus in the midst of coagula of blood, which has led some observers to suppose that these coagula became organised and susceptible of inflammation and suppuration, I am disposed to think with M. Cruveilheir, that it is a phenomenon of capillary attraction merely, and that the coagulum is but a kind of filter, through which penetrate the secretions of the parietes of the vessel itself.

The instances of *encephaloide* matter found in the coagula by Velpeau, (in the *Revue Médicale*, t. i. 1825, and t. iv. 1826,) or even free in the cavity of vessels, have given rise to objections and explanations which we refrain from bringing forward. This author persists in regarding as primitive alterations of the blood, what we consider as not demonstrated in the present condition of science.

<sup>1</sup> Some chemical trials made by *M. Leuret*, (thesis already cited.) gave but negative results. At any rate we may regard the putrid decomposition of the blood altered by the pus as probably more rapid.

Still, according to M. Andral, (*Précis d'Anato. Patholog.*, t. i. 1829. *Lésions du Sang,*) the power which during life keeps the globules separate, may be so modified that the globules shall have a tendency to unite, and spontaneous coagulation of this fluid take place in the vessels. This coagulation sometimes takes place without any known cause, and is sometimes coincident with a state of irritation of the parietes of the vessel in which it takes place. When once solidified the blood exhibits unquestionable vital phenomena: vessels are formed and secretions take place, and various changes of nutrition, like those which occur in the normal tissues, arise. It must then be admitted, that these polypiform concretions possess a sort of vitality by means of organs, which they have themselves created.

The question of polypi of the heart as they are sometimes called, has been much discussed. The physicians of the seventeenth and eighteenth centuries, admitted the formation during life of these fibrinous concretions, to the presence of which they attributed the various accidents subsequently referred to diseases of the heart and the circulatory and respiratory organs. Corvisart rejected this opinion, which was often undoubtedly unfounded; but modern observers have again admitted the existence of these polypiform concretions. We shall touch again upon this point in the next paragraph, when treating of alterations of the blood in arteritis and diseases of the heart, and shall also immediately refer to it again in describing the local accidents of phlebitis.

The local and constitutional symptoms which result from wounds in dissection have been ascribed in turn to inflammation and infection, by absorption, of the lymphatic system, and to phlebitis. (In *Velpeau, Revue Médicale*, t. ii. 1829, and *Archives Générales de Médecine*, 1835 and 1836; *Andral, Anatomie Patholog.*, t. i. *les. du Sang*; *Cruveilhier, Anatomie Pathol.* in folio, and *Dictionn. de Médec. &c.*; and especially the recent work of M. Rayer upon the *Glanders*, which was quoted above.)

Both of these lesions may be the result of envenomed wounds of this sort. Sometimes the puncture occasions inflammation of the lymphatic vessels and ganglia, and then as MM. Cruveilhier and Rayer have judiciously observed, the ganglia commonly serve as barriers to the absorption, and the evil is limited to local disorders, such as circumscribed abscesses in the course of the lymphatic ganglia and vessels. When, on the other hand, a true phlebitis is developed, the effects of absorption are most to be dreaded, either because a contagious matter is absorbed, and infects the blood as in *glanders* and diseases characterised by the malignant pustule; or because the pus itself, which is formed in the inflamed veins, becomes a source of infection, and brings in its train the grave accidents which have been detailed before. In order to prevent this absorption, and the spreading of the suppurative inflammation, M. Velpeau has proposed and applied with success in cases of this sort, compression above the wounds. (See the treatise quoted already

upon *phlebitis, phlegmonous erysipelas, wounds of anatomists, and the advantages of compression in the treatment of these diseases*, in vol. ii. 1829 of the *Revue Médicale*.) The common practice of cauterising the place of the puncture or cut, is nevertheless when seasonably done, the most certain.

Having treated of the general accidents of suppurative phlebitis, which unquestionably depend upon an infection of the blood, we must say something of the local accidents, so far as they are connected with an alteration of the blood. This last point in the history of phlebitis will serve as a natural mode of transition to those alterations of the blood, which are observed in arteritis, diseases of the heart, and lastly in plethora and inflammatory diseases.

According to M. Cruveilhier, (*Dictionn. de Médecine et de Chirurgie Pratiques*), the first effect of phlebitis is coagulation of the blood with adhesion to the vessels. This coagulation with adhesion to the vessels, is observed in traumatic as well as in spontaneous phlebitis. *Sasse* had already established this fact by his experiments in 1797, (*De vas. Sanguif. Inflamm.*) Having opened the veins of several animals, and moistened the lips of the wound with some acrid material, such as tincture of cantharides, or the juice of euphorbium, he uniformly found at the autopsy these veins furnished with a coagulum, or entirely obliterated. This first effect of phlebitis may be only a precaution of nature, to prevent as far as possible the progress of the inflammation, and the introduction of pus into the circulation. Most cases of phlebitis, if left to themselves, do not exceed that degree of inflammation which results in the coagulation of the blood with adhesion, and which may be called adhesive phlebitis. The serum of the coagulated blood is gradually absorbed, and at a later period the colouring matter also; the colourless fibrine sometimes becoming organised and traversed by vessels, and sometimes being itself removed by absorption.

The formation of compact, adherent coagula is injurious only when they occupy a certain extent, and interfere more or less with the circulation in the adjacent parts. Thus phlebitis of the sinus dura mater is fatal at an early period, because the venous circulation in the brain is interrupted. So also phlebitis of the femoral veins or external iliac results in œdema more or less severe of the lower extremities, and various local accidents arise from the difficulty, and sometimes the impossibility, of providing by the collateral branches for the carrying on of the circulation.

It should be remarked, that the coagulum of inflamed veins does not prevent an uniform consistency; that the outer layer which is in contact with the walls of the vein is most dense; that the central portion is the least so; that absorption commences always from the centre, while the subsequent phenomena of organisation are first developed in the outer layers. It is not uncommon to see the coagula deposited in large veins undergoing alterations similar to those exhibited in aneurismal sacs, and assuming the appearance of a pultaceous, grayish matter. This alteration of the blood, which

commences in the centre, and afterwards extends to the outer layers, may produce a subsequent inflammation of the walls of the veins, a local inflammation which sometimes results in an external abscess.

In a certain number of cases of phlebitis left to themselves, or treated unsuccessfully, the formation of the coagulum is but the first stage of the disease, the second being suppuration. There are certain miasmatic and constitutional conditions under which phlebitis almost necessarily becomes suppurative, in spite of the most judicious treatment. There are other cases, which become suppurative only when badly treated.

The local phenomena of suppuration of the veins are at first the appearance of pus, not between the coagulum and the vein, but in the centre of the coagulum. It is at first like lees of wine, sanguous, but afterwards becomes white, opaque and phlegmonous.

There are cases of suppurative phlebitis which do not pass this first stage, that in which the pus occupies the centre of the coagulum and then the pus is absorbed, and organisation or absorption of the coagulum takes place, without any indication of the presence of pus. If the phlebitis continues to progress, the proportion of coagulum diminishes, while that of pus increases, and still an adhesive phlebitis may be established beyond the place occupied by the pus, which shall limit the disease. It is to be observed, that in general the red colour of the inner membrane of the vessel diminishes as the colouring matter of the coagulum is absorbed, and that it finally disappears entirely, when the pus has taken the place of the coagulum.

Lastly, the disease reaches a stage in which the pus may become directly mixed with the blood, and by its stimulating and poisonous properties give rise to those general phenomena of phlebitis, the theory of which we have given above, in accordance with the ingenious experiments and explanations of Professor Cruveilhier.

SEC. VI.—*Arteritis, diseases of the heart, polypiform concretions.* According to M. Bonillaud, (*Dictionnaire de Médecine et de Chirurgie Pratiques,*) acute arteritis may produce a more or less abundant exudation of a plastic, coagulable, fibrinous matter in the interior of an inflamed artery. According to Hodgson, the quantity of this matter effused may be sufficient to obliterate arteries of large size. He has seen an obliteration of the left subclavian artery from this cause. MM. Roche and Sanson, (*Éléments de Pathologie Médico. chirurgicale,*) first announced this remarkable etiology of dry gangrene, called also gangrene senilis.

This disease, allied to arteritis, has more recently been made the subject of an excellent monograph by M. Francois du Haniaut, *Essai sur les Gangrènes Spontanées*, 1 vol. in 8vo. 1832.) The author admits the formation during life of fibrinous coagulations in the heart and arteries, and considers the inflammation of the internal membranes of the vessel, the most frequent cause of the coagulation of the blood which obstructs the artery and brings on gangrene. The action of the secale cornutum may also produce

gangrene by causing a suspension of the circulation in the extremities, but this is the immediate effect of some unknown alteration of the blood, which does not originate in an inflammation of the vessels. This specific alteration of the blood may also be seen under other circumstances. Thus Hildenbrand has seen gangrene of the extremities supervening upon *typhus*; Keraudren and Leloutre have seen it in the *yellow fever* of the Antilles. We might also imagine very different conditions leading to a similar result. Might we not, for example, consider the blood of plethoric persons as being in a state of alteration, which disposes it to coagulation and the formation of false membranes? May not this gross blood become of itself an irritating agent, acting constantly upon the inner surface of the vessels.

It is probable, according to M. Bouillaud, that in the case of severe and extensive arteritis, the blood contained in the inflamed arteries, and consequently the mass of the blood itself, experiences essential alterations.

It must be confessed, that this probability is much less apparent here than in the case of phlebitis; the obstruction of the circulation of the blood in consequence of the coagulation of this fluid being the first well marked phenomenon of arteritis, at least in branches of moderate size; and the arteritis of large vessels bringing with it from the first too great constitutional disorder to allow the inflammatory disease of the artery to pass through the stage of suppurative phlebitis. This is not the place to speak of the chronic lesions of the arterial tissue, which are also attributed by some modern authors to inflammation, these lesions not exercising any direct influence on the constitution of the blood. We shall soon recur to the influence which irritation of the large vessels may have upon the coagulation of this fluid.

In the year 1833, at the invitation of M. Gendrin, M. Lecanu submitted to analysis the blood of three men and five females attacked with affections of the heart, angiocarditis and endocarditis. These analyses proved, that there existed in these diseases a considerable diminution in the proportion of the globules (and of the fibrine) of the blood, and a proportional increase of the water, the amount of albuminous, saline, extractive and fatty matters remaining the same. (Thesis quoted, p. 110 and the following.)

Still further, the difference observed between the blood of females attacked with these affections and the blood of females in health, was greater than that between the blood of men attacked with the same affections, and the blood of men in health, which is probably the result of their greater impressibility. It is remarkable, that in a second bleeding of two invalids, whose blood had been analysed, the blood proved to be more abundant in globules, than at the first, contrary to what is ordinarily observed in a state of health and in inflammatory diseases.

The blood of the individuals quoted (with the exception of one particular case) did not differ physically from the blood of persons

in health, except in its greater fluidity, the extreme smallness of the coagulum, and the enormous quantity of serum. It had never any buff.

These results lose much of their importance for the want of the medical notes, which should have accompanied them, but which M. Lecanu could not procure. Nevertheless, they agree with clinical observation, which teaches that diseases of the heart are a frequent cause of dropsy, and also help to explain the occurrence of serous effusion in similar cases, by showing that there exists a true watery cachexy analogous to what is observed in general dropsy. But they are at variance as regards the *endocarditis* and the *angiocarditis* with the prevailing theories, at least in as much as under these terms the physician who furnished the blood for M. Lecanu's analysis, omitted to take notice of those chronic alterations (ossifications, vegetations, contractions of the valves, &c.) which are frequently met with under the preceding classification, and are explained in the same manner.

The *polypiform concretions* of the heart, admitted by *Malpighi* (oper. omn. 1666, *de polypo cordis*) and by many later writers, especially the philosopher and skilful practitioner *Fr. Hoffmann*, (Med. ration. systemat. tom. iv. p. 3. 1738. Cap. i. *De palpitatione cordis*,) and by the celebrated *Van Swieten*, (Comment. in aphor. tome iii. in 4to. 1758, § 1010,) who ascribed to them the symptoms of grave organic lesions of the heart,<sup>1</sup> were disputed by *Morgagni*, *Sénac*, *Pasta*, (*Epist. de cordis polypo in dubium revocat. Bergame, 1739.*) and *Lieutaud*, *Corvisart*, and *Laennec*, hardly admitting their formation during life except in some rare cases, and a short time before death.

Recent facts have demonstrated that these polypiform concretions may exist during life. M. Ferrus, at one of the sittings of the Academy of Medicine (1828) reported, that at a venesection he had drawn from the vein of an arm, which was suddenly swollen and of a livid blue colour, a coagulum of considerable length.

M. Velpeau exhibited at the same time to the same audience, a vena cava filled by a central non-adherent coagulum, which had been arrested by the emulgent veins, and exhibited in some places a degeneration like medullary matter. Bouillaud, *Traité des Maladies du cœur*, offers, among other remarkable examples, the curious fact of a heart, the right auricle of which was nearly filled

<sup>1</sup> Van Swieten cites a curious observation from Petrus Salius Diversus, (*De febre Pestilent. et Affect. Partic. Cap. iv. p. 238.*) a young girl, fourteen years of age, experienced heaviness of the head, anxieties, vertigos, and suddenly died the next day. At the autopsy, no cerebral alteration was discovered, but the blood was so coagulated in the aorta and vena cava: "ut apprehenso illius sanguinis concreti altero principio, totus sanguis coalitus ita integer ex venâ et arteriâ educeretur perinde ac gladius ex vaginâ extrahi solet." Van Swieten admits that in this case, the lesion of the cerebral functions preceding death must be attributed to the obstacle offered to the course of the blood by the formation during life of this polypous concretion.

with a soft gelatinous coagulum, containing in its centre vesicles filled with a semiconcrete fluid, traversed by an infinite number of bright and dark red vessels, &c. &c. M. Blaud de Beaucaire, in a memoir in the fourth volume, 1833, of the *Revue Médicale*, has collected a great number of facts derived from various authors, and from his own practice, which go to re-establish completely the existence of the polypiform concretions of the heart. According to him, many cases of sudden dyspnœa, deranged circulation, asthmatic affections, and palpitation of the heart, appearing suddenly and inexplicably, depend on the formation of such concretions during life.

The two principal causes to which modern authors have attributed the formation of polypiform concretions, are the stasis of the blood (during syncope, for example, or in organic lesions of the heart,) or inflammation of the internal membrane of the heart. A third cause should undoubtedly be added to these, viz. the constitution itself of the blood, which being more or less plastic, more or less easily concrescible, more or less abundant in fibrine and globules, is also consequently more or less susceptible of a spontaneous coagulation.

M. Magendie, in his lectures at the college of France, (t. vi. p. 252,) has furnished a table of these substances which promote or hinder the coagulation of the blood taken from the veins. Nearly all the acids, and many alkalies liquefy the blood. Prussic acid especially causes the fibrine and globules to disappear. Water on the contrary, favours the coagulation of the blood, which to M. Magendie seems to explain the fact, that if we inject into the veins of an animal a quantity of water equal to the quantity of blood taken away, the blood does not become more watery, and may even exhibit very little serum. Great caution must be used in drawing conclusions from such researches, for notwithstanding the effect of acids upon the fluidity of the blood, the Eau de Rabel and sulphuric acid are approved antihemorrhagic remedies. These researches may still help to explain how, under certain hygienic conditions, the blood may acquire more or less coagulability.

Much attention has been paid by modern observers to the distinction between polypiform concretions formed during life or after death; they are translucent fragile masses, in the centre of which a blackish coagulum is found, and adhere but loosely to the cavities in which they lay. If of somewhat earlier formation, they have no coagulum in their centre, and if older still, they are white, opaque, and fibrinous. When formed during life, they are still more dense, solid and fibrous. They ramify and adhere to different points of the texture of the heart, and sometimes exhibit marks of more complete organisation. Lastly, they may in some rare instances present purulent, medullary degenerations, &c. the origin of which some observers have sought for only in the sanguineous concretion itself.

SEC. VII.—*Plethora and inflammatory diseases in general.* The daily observation of physicians proves that in plethora and inflammatory diseases the density of the blood is increased. The coagulum is larger and firmer than usual, the globules are augmented, and the proportion of watery ingredients diminished. The quantity of albumen, of extractive, saline, and fatty matters, or of fixed matters of the serum, remains the same as in the ordinary state. M. Lecanu has found (*Journal de Pharmacie*, and thesis above quoted,) in plethoric persons, or those having inflammatory diseases, the maximum proportionals of globules (148.450) and the minimum of water (783.890) in man, and 129.990 for the globules in woman, 780.840 for the minimum of water.

The ordinary condition of inflammatory blood is a dense, firm, voluminous coagulum, from blood obtained by venesection or cupping, with a small proportion of serum. This condition is especially observable in acute rheumatism and pleuropneumonia. In connection with this condition of the blood, we often find on the surface of the coagulum, a layer of blanched, colourless fibrine, (that is to say, fibrine from which the globules on account of their increased density have become separated and precipitated into the lower parts of the coagulum) commonly called the *inflammatory buff*. Notwithstanding the remarks of some experimenters, this buff does afford important indications, and if it is sometimes found in diseases which are supposed at first sight not to be inflammatory, it is because some local inflammation has supervened upon these diseases.

The table of the specific gravity of serum in different diseases placed by M. Rayer at the end of t. ii. of his *Traité des Maladies des Reins* fully confirms the results of common experience. Thus in fourteen cases of pneumonia and pleurisy, the inflammatory buff appeared ten times; it is almost invariably found in acute rheumatism, and appeared three times in five cases of erysipelas of the face.

A memoir of M. Duges upon observations collected by M. Belhonime at the Hotel-Dieu, in the practice of M. Recamier, contains facts explanatory of the disagreement of authors as to the formation of the inflammatory buff. We will extract from this memoir some passages which bear particularly upon our subject.

"The blood in its ordinary state has a well known heat, odour, colour and consistency. When exposed to the air it exhales not only an odour but also a sufficient amount of aqueous vapour to lessen its weight, according to the report of Schwencke, one half in twenty-four hours, at the ordinary temperature, a phenomenon which I have often witnessed. This loss of the water undoubtedly promotes the coagulation, but that which chiefly effects it is a condensation, which some moderns have compared to muscular contraction, or morbid rigidity. This condensation seems to me to depend especially upon the gradual diminution of the expansion of the blood in the living body. We know indeed, according to Rose, that a given weight of blood occupies a space ten times greater in the living than in the dead body, (a phenomenon which is owing

chiefly to the transudation of the aqueous part through the parietes of the vessels.) This refers particularly to arterial blood, which, according to Walreus, is four times more rarefied than venous blood. Soon after the coagulation, the separation of the coagulum and the serosity commences. The first composed of fibrine and colouring matter float in the form of a cake, contracts itself more and more, squeezes out, so to speak, the serum which it contains, and at the same time assumes upon its upper surface a bright red colour; after which, in certain cases, this surface becomes blanched and covered with a coating of an albuminous appearance, but which Deyeux and Parmentier have found to be composed of fibrine, although Vauquelin and Thénard have also found albumen in it.

After this period, the phenomena of acid and putrid fermentation commence.

The natural processes and phenomena which we have described by no means present themselves always under the same aspect.

Thus it has been remarked in general: first, that the blood was more frothy, more odorous, warmer, more concrescible, more fibrinous, and less serous in carnivorous animals, especially at the period of rutting, in males who are robust and disposed to inflammatory affections, and also in men with red hair, (*Burgraff*.) Sénacl has seen the blood coagulate while issuing from a vein and fall upon a basin in the form of a string. The blood has been found coagulated in the veins of an epileptic person by Stahl, of an apoplectic by Highmore, and under circumstances, by several physicians quoted by Haller. It has also been supposed, that a temporary coagulation of the blood might take place in syncope, in the same manner that Spallanzani observed it in his experiments on cold-blooded animals.

2. That in all persons having in themselves an occasion of over excitement, as is the case in pregnancy, pleurisy, &c. the coagulum is covered with a white buff, which is often very thick.

3. That on the contrary, in certain diseases, the blood seems to be decomposed, losing its fibrine and increasing its proportions of gelatine and albumen, just as it is found to be naturally in the fœtus, (*Deyeux and Parmentier*,) or even becoming suddenly liquefied, and so attenuated and incoagulable as to transude from all the textures during life. This is seen in scurvy (*Van Swieten, Lind, Sprengel, &c.*) in acute pestilential and exanthematous fevers, in hydrophobia (*Magendie*); under the action of various poisons, of pain and fatigue; in inanition and asphyxia. I have given many examples of this sort in the *Essai sur la Fièvre*. (t. i. p. 380 and 387,) and they are to be found in great numbers in the work of Huxham, the physiology of Haller, the *Traité de l'Expérience* of Zimmermann, and in the medical journals.

4. Still further, the blood has been found in some diseases like porridge, or milk, (*Van Swieten, Haller*.) Morgagni has found it cold and fetid; Bichat has seen it puriform in the vena porta; I have seen it slimy and putrid in consequence of gangrenous phleg-

mon. Zimmermann, Enaux, and Chaussier, speak of a poisonous acid and corrosive blood, causing inflammations of the skin and even gangrenous inflammation; Deidier by injecting the blood of persons sick with pestilential disorders into the veins of animals quickly caused their death. Finally, the blood of jaundiced persons is loaded, on the testimony of Fourcroy and Professors Clarion and Orfila, with the colouring matter of the bile; and it cannot be denied, that articles of the *materia medica* are frequently diffused in a perceptible manner through the circulating fluids. I have elsewhere reported many proofs of this (l. c. t. i., p. 435.) Kaw Boerhaave, Haller, Nuck, MM. Mayer, Meckel, Magendie, Westrumb, and others, have also found it by experiment.

To these remarks we may add;

1. That the heat of the atmosphere, muscular exercise, strong passion, and diurnal excitation, increase the force of the circulation, and it is easy to conceive how these circumstances, by placing the person in the same condition as those under a febrile excitement, may render the blood more red, more concrescible, and more buffed; but it would be very difficult to explain how the degree of constriction of the size of the vein, the extent of the excision (*Zimmermann*), the rapidity and direction of the jet (*Sydenham*), and other like circumstances (*Schwenke*) can promote or prevent the formation of a pleuritic buff.

2. It would be equally difficult to explain the influence which the form of the receiving vessel has upon this phenomenon. De Haen has remarked, and I have frequently observed, that a narrow vessel gives a thicker buff, and a large one frequently presents none. Schwenke has made the same observation.

3. The medium through which the blood passes, or in which it is received, also changes its aspect considerably. A temperature above 35° centigrade, or below 0°, is equally unfavourable to the separation of serum, and causes a homogeneous coagulation, (*Schwenke*.) The contact of air is also necessary for this separation (*Schwenke, Senac, De Haen*.) When received in water, the blood solidifies it in the proportion of three or four twentieths, according to Schwenke, but soon it separates from it and coagulates in distinct masses. If mixed in a large quantity of water, the blood exhibits divers tints, observed by our worthy associate Doctor Andral. If the blood is in small proportion, the water is yellowish, then greenish, next of the colour of rust, and lastly red, as the quantity of blood is increased. Thus may be explained the colouring of pneumonic sputa, of the skin of new-born children, the various tints of the ecchymoses in typhus icterodes, and other affections, whether febrile or caused by the bite of venomous insects, and finally the yellow colour found by experimenters in the blood of the embryo and especially of the chick.

4. Motion, agitation of the blood also prevents coagulation; it detaches the fibrine from it, and Ruysch thus obtained his *membrane of the blood*.

The following propositions may be deduced from the labours of M. Belhomme, based upon more than one hundred and fifty observations, collected with great care under the direction of Professor Recamier : 1. The contradictions observed by authors may be explained by the different combinations of the external and internal or individual conditions ; 2. Sthenic and inflammatory affections or dispositions, occasion the formation of the *pleuritic buff*, and the departure of the blood, if the opening of the vein be large, or the vessel into which the blood is received narrow ; 3. Sometimes the individual conditions are so powerful that their influence is scarcely modified by external circumstances, sometimes, on the contrary, they are annulled by the latter ; more often these conditions increase or diminish their effects by their concord or opposition. (Consult the *Revue Medicale*, t. i. 1824. Observations made at the Hôtel Dieu during the year 1823, upon the blood and the inflammatory buff.<sup>1</sup>)

SEC. VIII.—*Acute Rheumatism, Gout and Gravel.*—It appears to us certain, says M. Roche, (Dict. de Méd. et Chir. Prat., article *Arthrite*,) that in *rheumatism*, besides the articular inflammation, there exists an alteration of the blood, which partly holds the latter in dependence. The principal clinical reasons on which the author rests his opinion, are the signs of *plethora*, the tendency to congestions of different organs and to hemorrhages, *buff* presented by the blood on bleeding. The *gout* also presents a profound and general modification of the economy, which consists in an extreme *animalisation* of the liquids and solids of the living body. According to M. Roche, a single cause produces the *gout*, and this cause is too succulent a diet. *Gravel* must be attributed to an analogous cause. All physicians, who have observed the *gout* in many cases, have remarked that it often alternated or coexisted with *nephritis* or *gravel*. Chemical analysis, by demonstration of the presence of uric acid in tophaceous concretions, and in the urine and *gravel* they sometimes convey, have pointed out a farther relation between these affections. Who has not, for example, seen the *gravel* cease and reappear alternately in the same individual, whom reverse and success have caused to pass from a frugal table to good cheer, and vice versa ? (Vide, *Researches upon the Gravel*, by M. Magendie, second edit. Paris, 1828.)

M. Rayer (*Diseases of the Kidneys*, t. ii.) has cited facts tending to confirm the relations established by medical experience between

<sup>1</sup> MM. Troussseau and Leblanc have published together, in the *Journal of Veterinary Medicine*, experimental researches upon the physical characters of the blood, in health and in disease. The first part of this interesting work alone is published ; it embraces researches into the influence exerted by various accessory circumstances upon the appearance of the blood in bleeding ; the authors conclude from their experiments, that these influences are so marked, that if not taken into the account no available induction can be made from the inspection of the blood. They propose a kind of machine, called *hématomètre*, to be employed in its inspection, in order to be sure that it always complies with the same identical conditions.

the gouty and rheumatismal affections and certain alterations of the kidneys and urine. (Consult in the volume cited the chapters upon *Néphrite Goutteuse*, p. 42 to 72, and on *Néphrite Rhumatismale*, p. 75 to 96.) The same author (Op. cit. t. i. p. 242) observes that no one has yet demonstrated the accidental presence of *uric acid* in the blood, either as cause or effect of diseases; nor has any one known by experiment the presence of the urates; but what chemical analysis has not demonstrated, pathological induction tends to establish. In fact, it has been shown, that the arthritic deposits around the fibrous sheaths of tendons were principally composed of the urate of soda;<sup>1</sup> and the formation of these arthritic deposits has been attributed to this circumstance, because no uric acid is met with in the urine during an attack of the gout. It has also been said, that the analysis of the bony calculi frequently found in the arteries of the gouty, demonstrates the existence of a certain quantity of urates; so that it appears very probable that the blood in gout is loaded with uric acid, urates, or their elements. Moreover the alkaline drinks, and especially the water of Vichy, the administration of which *renders* the urine *alkaline*, are of equal benefit in individuals afflicted with gravel or the gout, (see the several memoirs of M. Charles Petit, inspector at Vichy, upon the *gout, gravel, and calculous affections*.) A very curious experimental fact with regard to the waters of Vichy, cannot be passed over in silence. From the preceding experiments of M. Magendie (The fourth volume of Lectures at the College of France,) it would have been natural to suppose that this alkaline water liquefied the blood, and therefore its use was better indicated in the gouty and gravelly, in whom the blood is often rich and thick. But direct experiment does not favour this opinion; for, after the trials made by M. Magendie of various reagents upon the blood drawn from the veins, he has been obliged to rank the water of Vichy among the agents which *favour* the coagulation of the blood.<sup>2</sup> We have already pointed out how much physicians should be upon their guard against the conclusions that might be drawn from this sort of experiments renewed by the medico-chemists of the seventeenth and eighteenth centuries, (especially in the writings of *Pringle* and *Huxham*, already cited.) A fact recorded by M. Magendie

<sup>1</sup> *Fourcroy*, (Syst. des Connais. Chim. t. x. p. 267.) *Wollaston*, (on gouty and urinary concretion. Philos. Trans. 1797, sect. ii. p. 386.) *Vogel*, (Bulletin de Pharm. t. iii. p. 386.) *Scudamore*, (Traité de la Goutte, Trans. of Deschamps, p. 290, 421.) *Saugier*, (Journ. de Chim. Méd. t. i. p. 6.) These authors found the gouty concretions composed of uric acid combined with soda or lime; *M. Barruel* found them composed of urate of soda and phosphate of lime, (Cruveilhier. Anat. Path., 10th book, p. 5.)

<sup>2</sup> M. Orfila had previously proved that *potassa* injected into the veins of a living animal, coagulated the blood and instantaneously destroyed life; while in contact with this liquid out of the vessels, the alkali, on the contrary, prevented its coagulation. (*Saucerotte*. Essays upon the alterations of the fluids considered as the causes or complications of diseases. Thesis, August, 1828.)

singularly supports the prudent reserve we have counselled. We read upon the 244 and 248 pages of t. iv. of his lectures, long and ingenious details upon the blood of a hog, killed in perfect health; this blood presented a very remarkable phenomenon, such a want of fibrine, that it remained liquid and *incoagulable*. Our surprise and that of the honourable professor are at an end, when we read, at the bottom of page 389 of the same volume, the following note:

"The explanation of this embarrassing phenomenon is perfectly simple. The butcher, who bled the hog, had, in conformity with his usual custom, beaten, or in other words **DEFIBRINATED THE BLOOD!**"

Another example, but more grave, because in the human subject, and which we present without comment, is the following:

"Called to a patient in whom the variola had suddenly put on the form called by the vulgar, the purple: upon **AN EXPLORATORY BLEEDING** the blood was found incoagulable. The fatal prognosis indicated by this circumstance was soon realised; *in a few hours* the patient no longer existed!" (Op. cit. t. iv. p. 383.)

SEC. IX.—**VISCERAL DISEASES WITH ALTERATIONS OF THE BLOOD.**—*Lesions of the urinary apparatus.* *Lesions of the biliary apparatus.* *Lesions of the spleen.* *Lesions of the respiratory apparatus.* We have already taken occasion to speak of the principal diseases of the urinary apparatus (*diabetes*, *albuminuria*, *nephritis*, *gravel*,) which are intimately connected with the state of the blood. M. Rayer, whose labours have thrown so much light upon these diseases, and who has already served as our guide, has been assiduously occupied with the relations existing between this kind of affection and the alterations of the blood, of which the urinary secretion is evidently a means of depuration and elimination.<sup>1</sup> To what has already been said, we will add but a few words upon that alteration of the blood which succeeds the suppression or retention of the urine. The first volume of the work, already so often referred to by M. Rayer, from page 227 to page 240, contains the most detailed and interesting researches upon this subject, which we can here only skim over.

In speaking of the experimental researches upon *diabetes* and *albuminuria* we said, that the blood, which in the healthy state affords no traces of *urea*, presents unequivocal evidence of it, when the secretion of urine is entirely suspended, (Exper. of *Prévost* and *Dumas*, *Gmelin*, and *Tiedemann*, [Extirpation of the Kidneys,])

<sup>1</sup> "The urinary secretion," says M. Rayer, "modifies the constitution of the blood, either by removing from it accidentally certain necessary principles, or by not freeing it from the elements which naturally should have been separated, or the proportion of which ought to have been diminished. On the other hand, the alterations of the urine are sometimes the consequences of the alterations of the blood; at times a double anomaly appears in the course of the same disease, the alteration of the urine by the alteration of the blood, and the alteration of the blood through the fault of the urinary secretion."

*Marchand, O'Shaughnessy, [Cholera.]* This principle has also been discovered in the blood by Christison, (Edin. Med. and Surg. Journal, vol. xxxii. p. 271-283,) in certain dropsies with albuminous urine. It must, however, be borne in mind that the action of the nitric acid, which ordinarily serves (by the formation of the *nitrate of urea*) to demonstrate the presence of urea in the blood of some dropsical individuals, may occasion the formation of a product analogous in aspect to the nitrate of urea obtained from the treatment of the alcoholic extract by the nitric acid. M. Raspail also has contested this discovery in the blood.

On the other hand, clinical observation has demonstrated the existence, in certain cases of a *retention of urine*, of a true *urinary fever*, in which all the excretions of the economy exhale an odour of urine, and seem to announce the presence of urea, either absorbed or retained in the blood. We must observe, however, that *urea* injected into the blood of dogs by M. Ségalas, and administered to the dropsical by M. Rayer, produced no accidents of this kind; did not, in fact, give rise to any accident. (Vide Boerhaave, Prælection. Acad. t. iii; Bichat, Researches upon Life and Death; Nysten, Rech. de Phys. et de Chim. Path.; Ségalas, Traité des Retentions d'Urine, &c.)

*Icterus* offers to physicians phenomena, which will hardly allow them to throw aside the opinion of the vulgar, that *the bile has passed into the blood*. Among chemists, some assert that the blood of icteric patients always contains bile; others on the contrary, that it does not contain any, and owes its colour to the presence of a peculiar colouring matter; others finally, adopting a middle opinion, assert that, without containing bile, the blood of the icteric contains its colouring principles. Among the former, may be reckoned M. Orfila, (Elém. de Chim. t. ii. p. 313,) and Clarion, (Thesis of the Faculty, 1811); among the second, M. Thénard, (Chim. t. v. p. 111,) and Lassaigne, (Journ. de Chim. t. i. p. 266); among the latter, M. Chevreul, (Dict. des Scien. Nat., art. Sang,) F. Boudet, (Thesis of the School of Pharm. 1833,) Collard de Martigny, (Journ. de Chim. Med.,) and Lecanu, (Journ. de Pharm. t. xvii. 1831, and Thesis Cit.) The latter author, in discussing these various opinions, makes mention of a curious experiment recorded in vol. i. p. 439, of the Physiology of M. Richerand. He there relates that M. Thénard, having analysed the blood of an animal, into the veins of which a great quantity of bile had been injected, could not discover a single atom of this fluid; which seems to indicate, both that our known means of analysis could not detect the bile in the normal blood, and that this bile, when by any cause introduced into the torrent of the circulation, almost immediately takes on the decomposition suspected by Legallois. M. Lecanu adds, that in the blood of two icterics analysed by him, he found the proportion of globules (including the fibrine) remarkably diminished. M. Martin-Solon discovered the colouring principles

of the bile in the blood of individuals labouring under *bilious pleuro-pneumonia*, (see vol. xii of the *Bullet. de Thérap.*)

The spleen generally offers a state which agrees with that of the blood itself. Thus as M. Roche justly remarks (art. *Splenite*, Dict. de Méd. et de Chir. Prat.) in animals into whose veins putrid matter has been injected, and in all miasmatic poisonings so grave as to occasion death in man, we find black spots, a kind of ecchymoses, a sort of dissolution of the blood in the tissue of the spleen, which is also observed in scurvy.

It is by examination of the lesions of this organ, that M. Andral has been confirmed in a previous opinion, with regard to the developement of certain accidental productions, which, according to him, are at first merely an effusion of fibrine. I have seen nothing, says he, (Dict. de Méd. vol. 21,) in certain cases designated as cancerous masses of the spleen, but a discolouration of the blood contained in a certain number of cellules of the spleen, with alteration of its consistence.

The lesions of the organs of respiration exert naturally a very great influence upon the state of the blood, which supplies them with the *pabulum vitae*.

The experiments of Bichat, those of Messrs. Dupuytren and Dupuis, that of Magendie, and common observation, demonstrate that in *asphyxia*, black blood flows in the arteries as well as in the veins, and that in the latter vessels it is deeper than usual. We know that the respiratory passages are those by which the miasma and emanations from decaying bodies almost exclusively penetrate to affect the blood.

Morton (Phthisiolog. 1689,) assigned as the proximate cause of *pulmonary phthisis*, an alteration of the hematosis and innervation, induced by various causes, and especially by melancholic affections. He considers, that the *acrimony* of the serum of the blood irritates the tissue of the lung, and provokes the developement of tubercles and ulcers. M. Roche, in the article *Phthisis* of the Dictionary already so frequently cited, has developed the theory of the production of this disease, so nearly allied to the *scrofulas*, by the alteration of the blood and humours.

SEC. X.—*Lesions of the apparatus of innervation. Diseases of the skin. Induration of the cellular tissue.*—Every one is aware of the close connection existing between the circulatory and nervous systems. M. Andral is led to believe, from the celebrated experiments upon the section of the pneumo-gastric nerve in horses, made by Dupuytren and Dupuy, that independently of the indirect effect then produced by the dyspnoea, there may also be a direct effect produced upon the blood by the suspension of the nervous action. The rapid diminution of the fibrine of the blood in these experiments seems to support this opinion, and it is also well known that asphyxia produces incoagulability of the blood. There may, in general, be observed in the melancholic a deep tinge of the

venous blood which coincides with torpidity of the circulation, and the brown tint of the skin.

There was a time when (especially in England) almost all chronic *diseases of the skin* were attributed to a scorbutic taint. Lind, in his Treatise upon Scurvy, with reason declaims against such a crying abuse of language. The *acrimony of the blood*, suspected by the physicians of the last century, in the same diseases, has not a more solid foundation than the scorbutic taint of the English; so that although we may recognise the union between diseases of the skin and a special crisis of the humours, we must acknowledge that this secret disposition is unknown to us, unless it consists in a scrofulous or venereal taint, in which case the physical characters of the cutaneous disease suffice to point out the nature of the evil.

The blood obtained by incisions of the skin of infants deceased with an *induration of the cellular tissue*, analysed by M. Chevreul (Dict. des Scien. Nat., art. *Sang*,) furnished a fibrinous matter of slight tenacity. The serum separated from the clot became entirely of the consistence of jelly, either because it held in solution a peculiar matter spontaneously coagulable, or because the albumen placed in peculiar circumstances experienced a true coagulation.

SEC. XI.—*Rare and unusual alterations of the blood.*—Many observers both ancient and modern (vide the Thesis of M. Lecanu,) have had occasion to observe the blood in bleeding present the aspect of an emulsion or of milk. This singular fact has been recorded in certain cases of diabetes, dropsy, puerperal peritonitis, nephritis, &c. It was for a long time supposed that this blood contained milk, or at least one of its elements, *caseum*, a fact which would have been of great importance for the theory of the *milk* diseases. But M. Lassaigne (Journ. de Chim. Méd. t. vii.) and several other modern chemists, both native and foreign, have demonstrated that this pretended lactescence was simply due to the presence of a fatty matter, which is not probably always identical. Messrs. Christison and Lecanu, always found it, like most of the fatty matters of the animal kingdom, composed of oleine, margarine, and stearine. In one analysis by M. Lecanu, the red globules had disappeared, and the fatty matter was so abundant that it might with reason be supposed to have supplanted them. M. Caventou, alone, has had an opportunity of examining blood rendered milky, not by the presence of fatty matter in suspension, but by a peculiar condition of the albumen, so that it rather resembled the white matter of chyle than ordinary albumen. (Journ. de Chim. Méd., t. iv. p. 608, and t. v. p. 132. Annal. de Chim. et de Phys., t. xxxix. p. 288.)

M. Rayer, (Op. cit. t. i.) has related some facts to show the co-existence in certain subjects of *chylous* urine, that is, urine loaded with fatty matter, and an analogous alteration of the blood. It remains to be seen, whether in the cases where *milky* blood has been

mentioned without speaking of the presence of the fatty matter in the urine, this excremential liquid has been duly examined.

In 1829, M. Gendrin published his observation upon a man labouring under vertigoes, whose blood, while issuing from the vein, was turbid, of a clear red, and became whitish red and marbled, as it became chilled. Some drops, which fell upon the floor, whitened in a few moments, and took the aspect of chocolate. At the expiration of half an hour the clot was swimming in a great quantity of white and opaque fluid, precisely similar to milk. According to M. Raspail, these phenomena were owing to the unusual presence of an acid, (proved by the action of the liquid upon the floor,) which, by favouring the coagulation of the albumen, had produced the marbled aspect of the blood and milky aspect of the serum. M. Caventou could not by analysis detect any albumen in this serum.

Air has frequently been found in the blood-vessels after death. Morgagni (Epist. v.) endeavours to explain this circumstance by causes foreign to putrefaction. It is a point demanding new researches. To this end the celebrated author of *The Seat and Causes of Diseases* is occupied with these introductions, artificial and accidental, of air into the great venous trunks, which have been the subject of recent academical discussions.

Some facts relative to the odour, taste, temperature, and electric state of the blood, are disseminated in the fasti of the science; but the most prominent have already been cited in the course of this dissertation, the remainder have not as yet acquired sufficient importance to be taken into the account.<sup>1</sup>

Finally, pressed by time and space, we terminate this dissertation by repeating with Fernel.

"Humorum affectus, etiam si contra naturam sint, morbos non dicimus." We are of the opinion of the celebrated physician of the sixteenth century, whose language has been cited by the authors of the article *Blood*, in the Dictionary of Practical Medicine and Surgery, that the humoral alterations, primitive or secondary, must be studied as capable of revealing the cause or taking part in the general picture of disease, but that the latter is a *vital act*, of which the solids are the principal instruments.

<sup>1</sup> The kindness of M. Dezeimeris has placed at my disposal, when the composition of this dissertation was nearly finished, a copy (belonging to Professor Roux) of a German work upon the alterations of the blood, published in 1836, by Hermann Nasse, at Bonn. This work appears to be simply a detailed exposition of numerous experiments upon the blood, mostly with regard to its physical and chemical relation.

The pathological part treats merely of *inflammation*. This book, valuable no doubt as a source of bibliographical reference, does not appear to contain any original researches, so far as a rapid examination would allow us to judge.

We have not thought it necessary to append a bibliographical list; the numerous citations in the text supplying the deficiency.